Motor Starters & Contactors — Low Voltage

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Specifications:

See Eaton's Cutler-Hammer Product Specification Guide on enclosed CD-ROM:

1995 CSI Format: . . . . . **Sections 16481, 16484, 16485, 16902**

2004 CSI Format: . . . . . **Sections 26 29 13.11, 26 29 13.13, 26 29 13.15, 26 29 05**

IT. Starter and Enclosed IT. S801 Soft Starter

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MS Manual Starters

Maximum 1 hp, 120/277 Volts Single-Phase

General Purpose Type 1 Enclosed MS Starter

Application

MS manual single-phase starters are designed to give positive, accurate, trouble-free overload protection to single-phase motors rated up to 1 hp. Typical applications are fans, machine tools, motors, HVAC, etc.

Table 31.1-1. MS Ratings

Volts	hp	Poles
120/240 V, 277 Vac	1	1 or 2
120/240 Vdc	1	2
240 Vdc	1/4	1
32 Vdc	1/4	1 or 2

Enclosures

- Type 1: General Purpose.
- Type 1: Flush Mounted, General Purpose.
- Type 3, 4, 5: Watertight.
- Type 7D: Class I, Group D Hazardous Locations.
- Type 9E, F, G: Class II, Groups E, F, G Hazardous Locations.
- Red pilot light available for NEMA® 1, factory installed or field installed kit.

Typical Specifications

Manual single-phase starters shall be Eaton's Cutler-Hammer® Type MS or approved equal for motors rated not greater than 1 hp. They shall be built and tested in accordance with the applicable NEMA standards.

The starter shall have a "quick-make, quick-break" toggle mechanism. The overload shall have a field adjustment allowing up to ±10% variance in ratings of the nominal heater value.

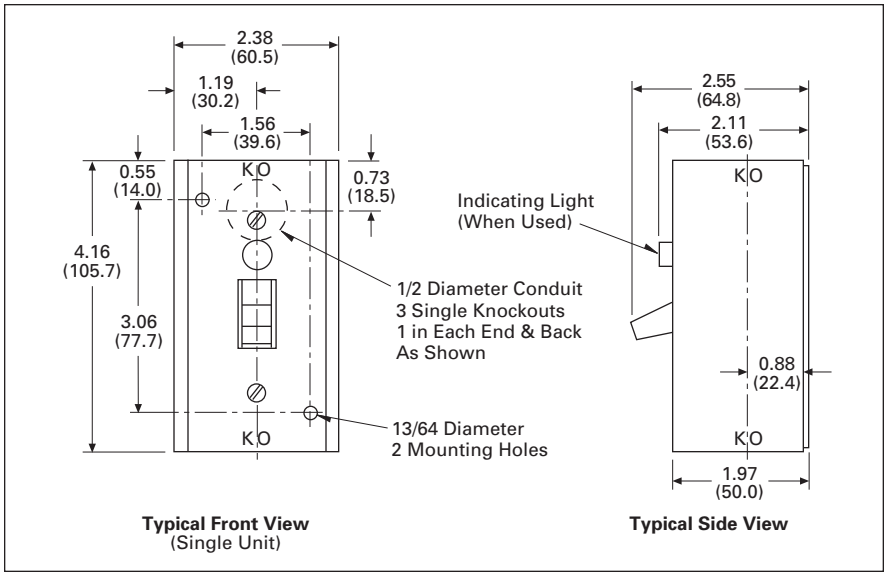

Figure 31.1-1. Type 1 Enclosures (Boxes and Covers)

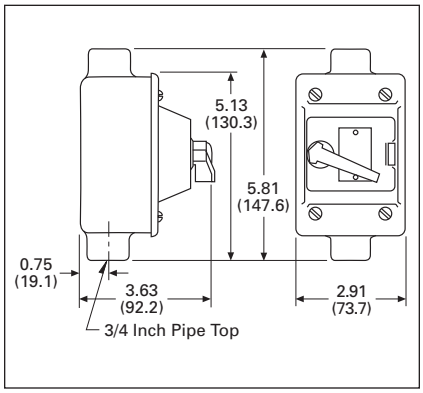

Figure 31.1-2. Watertight (Cast Aluminum)

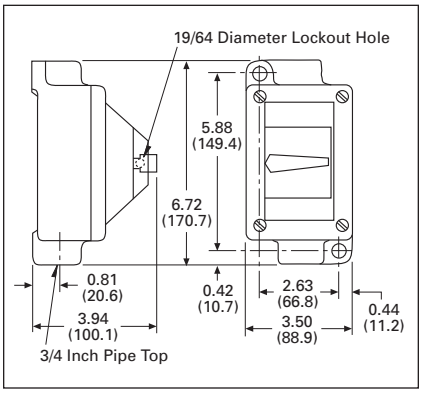

Figure 31.1-3. Hazardous Location (Cast Aluminum)

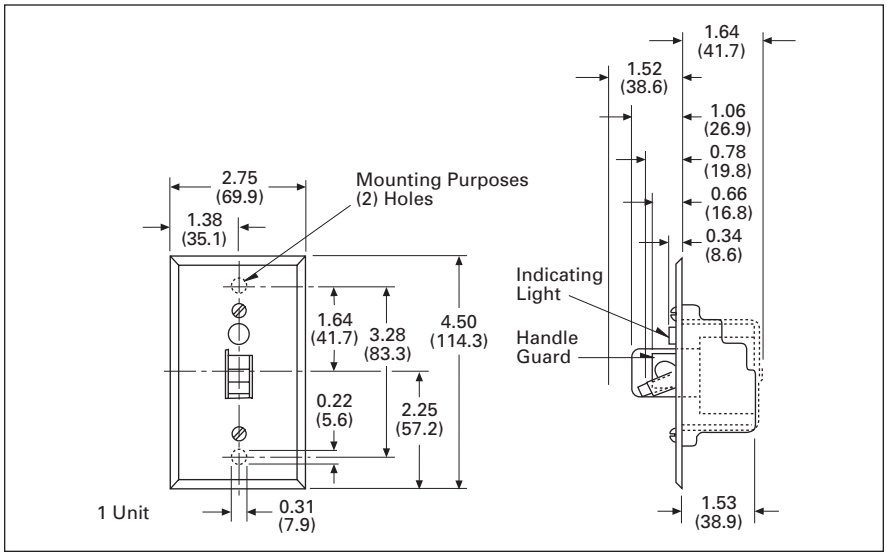

Figure 31.1-4. Flush Plates

Dimensions in Inches. Not to be used for construction purposes unless approved.

Type B100

Maximum 10 hp, 600 Volts

General Purpose Type 1 Enclosed B100 Starter

Enclosures

- Type 1: General Purpose.
- Type 4: Stainless Steel, Watertight.
- Type 7: Class I, Group D Hazardous Locations.
- Type 9: Class II, Groups E, F, G Hazardous Locations.
- Type 12: Dust-tight Industrial Use.

Table 31.1-2. B100 Ratings

NEMA Size	Maximum Horsepower		
	115 Vac	200-230 Vac	460-575 Vac
2-Pole, Single-Phase ac			
M-0	1	2	—
M-1	2	3	—
M-1P(1-1/2)	3	5	—
3-Pole, 3-Phase ac			
M-0	2	3	5
M-1	3	7-1/2	10

Typical Specifications

All 3-phase manual starters and single-phase starters rated above 1 hp shall be Eaton's Cutler-Hammer Type B100 or approved equal. They shall be built and tested in accordance with the applicable NEMA standards.

The starter must feature contact operation which is "quick-make, quick-break" and cannot be teased into a partially open condition. There must be a provision which blocks the closure of the contacts while the line terminals are exposed. Operating handle or buttons must clearly show by their position whether unit is ON, OFF or TRIPPED.

Application

The Cutler-Hammer B100 manual starter can be used on non-reversing applications up to10 hp, 600 volts ac. It features a 3-pole block overload relay which utilizes A200 starter heaters, straight-through wiring, and will accept auxiliary contacts.

B100 starters are available as toggle or pushbutton-operated open and Type 1 enclosed devices, or toggle-operated in Type 4, 7, 9 and 12 enclosures with padlocking provision as standard. Red pilot lights and one auxiliary contact are available as options.

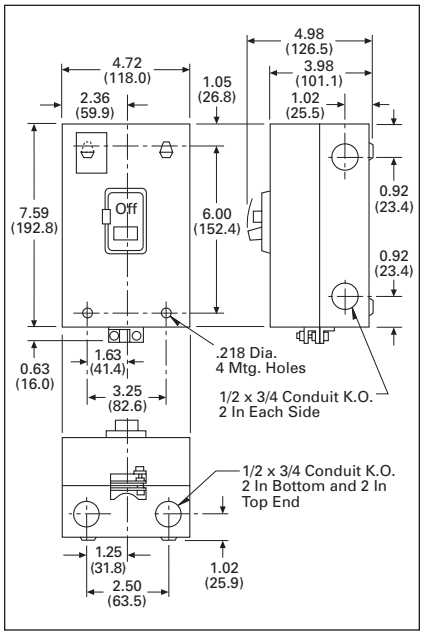

Figure 31.1-5. Type 1 Enclosed

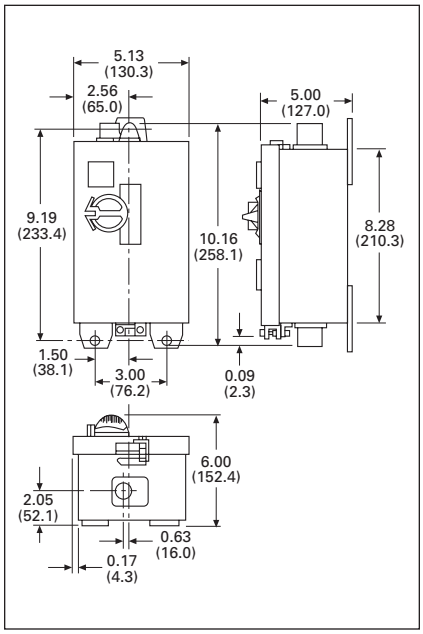

Figure 31.1-7. Type 4 Enclosed

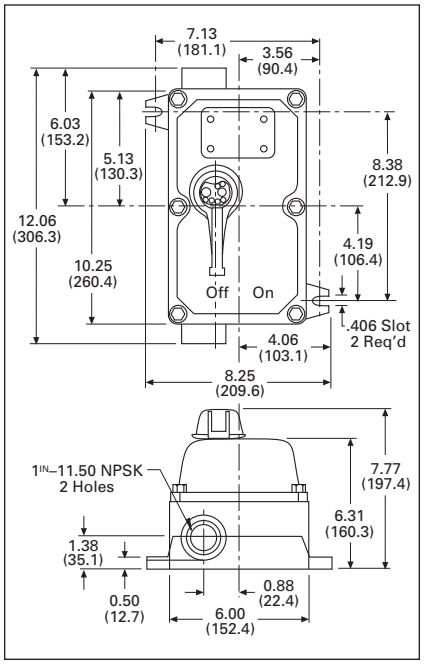

Figure 31.1-6. Type 7/9 Enclosed

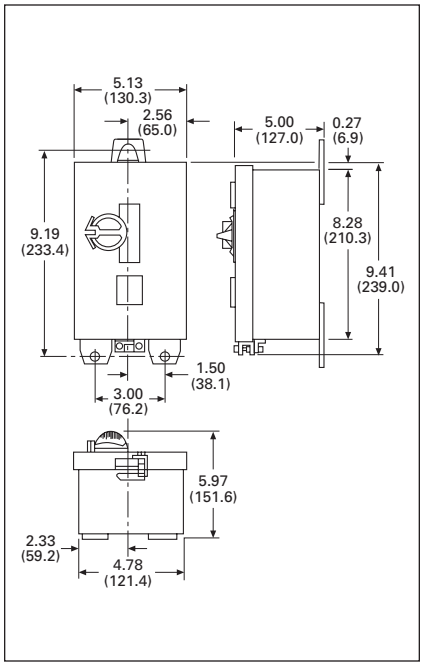

Figure 31.1-8. Type 12 Enclosed

Dimensions in Inches. Not to be used for construction purposes unless approved.

Non-Combination Lighting Contactors

60 Ampere, 5-Pole Electrically Held

30 Ampere, 12-Pole Mechanically Held

30 Ampere, 4-Pole Magnetically Latched

Product Description

Lighting contactors are designed to provide a safe, convenient means for local or remote switching of tungsten (incandescent filament) or ballast (fluorescent and mercury arc) lamp loads. They are also suitable for other loads such as low pressure and high pressure sodium lamp loads and other non-motor (resistive) loads. They are not recommended for most sign flashing loads.

These lighting contactors are designed to withstand the large initial inrush currents of tungsten lamp loads without contact welding. The full family of lighting contactors does not require derating.

Application Description

Loads:

Ballast Lamps — Fluorescent, Mercury Vapor, Metal Halide Sodium Vapor, Quartz — 600 V maximum.

Filament Lamps — Incandescent, Infrared, Heating — 480 V maximum, line-to-line; 277 V maximum line-to-neutral.

Resistance Heating — Radiant and convection heating, furnaces and ovens.

Typical Specifications

Electrically-Held Lighting Contactors — Eaton's Cutler-Hammer CN35 or approved equal are rated for lighting loads of 10 – 300 A. They are built and tested in accordance with applicable NEMA standards.

Mechanically-Held Lighting Contactors — Cutler-Hammer C30CNM or approved equal are rated for lighting loads of 30 A. They shall be capable of being supplied in a 2 – 12 pole single unit configuration.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contacts welding. The contactor is capable of being operated such that it will not switch to "OFF" during the control power circuit power failures.

Magnetically-Latched Lighting Contactors — Cutler-Hammer A202 or approved equal are rated for lighting loads of 30 – 4000 A. Magnetically-latched enclosed combination lighting contactors are Cutler-Hammer Type ECL12 (breaker) or ECL13 (fusible) or approved equal for loads up to 30 – 200 A when integral short-circuit protection is required.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contacts welding. The contactors are capable of being "mechanically held" via a magnetic latch design utilizing a permanent magnet. The contactor is operated by a RUN signal and a STOP signal preventing the contactor from switching to "OFF" during control circuit power failure.

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Table 31.2-1. Lighting Contactor Comparison

Ampere Rating	Number of Poles	Electrically Held	Mechanically Held	Magnetically Latched
10	2, 3, 4	**CN35**	—	—
20	2, 3, 4, 6, 9, 12	**CN35**	—	—
30	2, 3, 4, 5, 6, 9, 12	**CN35**	—	—
30	1 – 12	**C30CNE**	**C30CNM**	—
30	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
60	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
60	2, 3, 4, 5	**CN35**	—	—
100	2, 3, 4, 5	**CN35**	—	—
100	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
200	2, 3, 4, 5, 6, 8, 10, 12	—	—	**A202**
200	2, 3, 4, 5	**CN35**	—	—
300	2, 3, 4, 5	**CN35**	—	—
300	2, 3	—	—	**A202**
400	2, 3	—	—	**A202**

CN35-Open (ECL03-Enclosed)

20 Ampere

60 Ampere

Product Description

Lighting Contactors are designed to handle the switching of tungsten (incandescent filament) or ballast (fluorescent and mercury arc) lamp loads as well as other non-motor (resistive) loads. Ratings of 10 – 400 amperes, 1 – 12 poles, open or NEMA 1, 3R, 4/4X and 12 enclosed.

Application Description

Loads:

Ballast Lamps — Fluorescent, Mercury Vapor, Sodium Vapor, Quartz — 600 V maximum.

Filament Lamps — Incandescent, Infrared, Heating — 480 V maximum.

Resistance Heating — Radiant and convection heating, furnaces and ovens.

Cover Control — See Enclosed Control Product Guide PG.3.02.T.E Start-Stop and Hand-Off-Auto only.

Enclosures

Open, NEMA Type 1, 3R, 4/4X and 12.

Auxiliary Contacts

Eaton's Cutler-Hammer CN35 Lighting Contactors include a NO maintaining auxiliary contact mounted on right-hand side (on 10-ampere, 2- and 3-pole devices, auxiliary contact occupies 4th power pole position — no increase in width). Enclosed devices include a NO auxiliary contact only on the right-hand contactor. The 10 – 60 A devices will accept additional auxiliary contacts on the top and/or sides. The 100 – 400 A sizes will accept side-mounted auxiliaries only.

Typical Specifications

Electrically-held lighting contactors are Cutler-Hammer Type CN35 or ELC03, or approved equal for lighting loads of 10 – 300 A. They are built and tested in accordance with applicable NEMA standards.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. Contactors are capable of accepting up to 8 auxiliary contacts — top and/or side up to 60 amperes and side only up to 400 amperes. Contactors are capable of being operated by ac or dc control.

Table 31.2-2. Ratings — CN35 ac Lighting Contactors — Electrically Held

Maximum Ampere Rating ①	Number of Poles
10	2, 3, 4
20	2, 3, 4, 6, 9, 12
30	2, 3, 4, 5, 6, 9, 12
60	2, 3, 4 ②, 5 ②
100, 200, 300	2, 3, 4, 5
400	2, 3

① Listed ampere ratings are based on a maximum load voltage of 480 V for tungsten lamp applications and 600 V for ballast or mercury vapor type applications.

② Additional power poles mounted on side(s) of contactor.

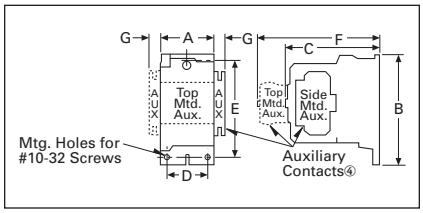


Figure 31.2-1. Open Type

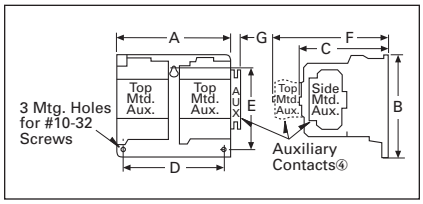


Figure 31.2-2. Open Type, 20 – 30 Ampere Sizes, 4 – 6 Poles

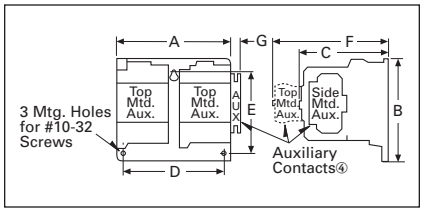


Figure 31.2-3. Open Type, 20 – 30 Ampere Sizes, 4 – 6 Poles

③ See "Auxiliary Contacts" for type and location of auxiliary contacts supplied.

Table 31.2-3. Approximate Dimensions and Shipping Weights

Ampere Rating	Number of Poles	Dimensions in Inches (mm)							Shipping Weight Lbs. (kg)
		Wide A	High B	Deep C	Mounting D ④	Mounting E	F	G	
Open Type									
10	2 – 4	2.00 (50.8)	3.88 (98.5)	3.49 (88.6)	1.50 (38.1)	3.38 (85.9)	4.90 (124.5)	0.54 (13.7)	1.4 (0.63)
20 – 30	2 – 3	2.00 (50.8)	3.88 (98.5)	3.49 (88.6)	1.50 (38.1)	3.38 (85.9)	4.90 (124.5)	0.54 (13.7)	1.45 (0.65)
20 – 30	4 – 6	4.20 (106.7)	4.35 (110.5)	3.52 (89.4)	3.50 (88.9)	3.86 (98.0)	4.90 (124.5)	0.54 (13.7)	2.9 (1.3)
20 – 30	9	10.50 (266.7)	5.75 (146.0)	4.52 (114.8)	4.50 (114.3)	5.00 (127.0)	—	—	4.35 (1.96)
20 – 30	12	10.50 (266.7)	5.75 (146.0)	4.52 (114.8)	4.50 (114.3)	5.00 (127.0)	—	—	5.8 (2.6)
60	2 – 3	2.56 (65.1)	5.05 (128.3)	4.44 (112.8)	2.00 (50.8)	4.50 (114.3)	5.80 (147.3)	0.54 (13.7)	3.4 (1.53)
60	4	3.46 (87.8)	5.05 (128.3)	4.44 (112.8)	2.00 (50.8)	4.50 (114.3)	5.80 (147.3)	0.54 (13.7)	3.5 (1.57)
60	5	4.36 (110.7)	5.05 (128.3)	4.44 (112.8)	2.00 (50.8)	4.50 (114.3)	5.80 (147.3)	0.54 (13.7)	3.55 (1.59)
100	2 – 3	3.54 (89.9)	7.17 (182.1)	5.94 (150.9)	3.00 (76.2)	6.63 (168.4)	—	0.54 (13.7)	9 (4.1)
200	2 – 3	7.05 (179.1)	9.11 (231.4)	7.25 (184.2)	6.00 (152.4)	8.50 (215.9)	—	—	20 (9.0)
300	2 – 3	7.05 (179.1)	13.12 (333.2)	7.78 (184.2)	6.00 (152.4)	12.50 (317.5)	—	—	23 (10.35)

④ Center mounting slot at bottom on 10 – 30 A sizes only.

Enclosed Box Selection

Table 31.2-4. Type 1 Non-combination Lighting Contactors — Electrically Held — CN35

Ampere Size (Poles)	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Contactors — without Control Power Transformers		
10 A (2P, 3P, 4P)	1	5 (2.3)
10 A (2P, 3P, 4P, 5P, 6P) w/top adders	2	7.3 (3.3)
10 A (9P, 10P, 12P, 20P)	3	9.5 (4.3)
20 A (2P, 3P)	1	5.2 (2.4)
20 A (2P, 3P, 4P, 5P, 6P) w/top adders & 6P w/o top adder	2	7.3 (3.3)
20 A (9P, 10P, 12P, 20P)	3	9 (4.1)
20 A (9P, 12P) w/top adders	3	9.3 (4.2)
30 A (2P, 3P)	1	5.3 (2.4)
30 A (2P, 3P, 4P) w/top adders	2	7.3 (3.3)
30 A (5P, 6P)	3	9.0 (4.1)
30 A (5P, 6P) w/top adders	3	9.2 (4.2)
30 A (9P, 10P, 12P, 20P)	3	9.5 (4.3)
30 A (9P, 12P) w/top adders	3	9.7 (4.4)
60 A (2P, 3P)	1	7 (3.2)
60 A (2P, 3P) w/top adders	3	9.8 (4.4)
60 A (4P, 5P, 6P, 9P, 10P, 12P)	3	9.5 (4.3)
60 A (4P, 5P) w/top adders	3	10 (4.5)
100 A (2P, 3P)	4	35 (16)
100 A (4P, 5P, 6P, 9P)	4	60 (27)
200 A (2P, 3P)	4	70 (32)
200 A (4P, 5P, 6P)	10	133 (60)
300 A (2P, 3P)	10	113 (51)
300 A (4P, 5P, 6P)	10	136 (62)
400 A (2P, 3P)	10	125 (57)
Non-reversing Contactors — with Control Power Transformers		
10 A (2P, 3P, 4P)	2	11 (5.0)
10 A (2P, 3P, 4P, 5P, 6P, 9P, 10P, 12P, 20P) w/top adders	3	13.1 (5.9)
20 A (2P, 3P, 4P, 6P)	2	11 (5.0)
20 A (2P, 3P, 4P, 5P, 6P) w/ top adders	3	13.1 (5.9)
20 A (9P, 10P, 12P, 20P)	3	13.5 (6.1)
20 A (9P, 12P) w/top adders	3	13.5 (6.1)
30 A (2P, 3P, 4P)	2	12 (5.4)
30 A (2P, 3P, 4P) w/top adders	3	13.1 (5.9)
30 A (5P, 6P)	2	12.5 (5.7)
30 A (5P, 6P) w/top adders	3	13.5 (6.1)
30 A (9P, 10P, 12P, 20P)	3	13.9 (6.3)
30 A (9P, 12P) w/top adders	3	14.1 (6.4)
60 A (2P, 3P)	2	12.8 (5.8)
60 A (2P, 3P) w/top adders	3	14 (6.4)
60 A (4P, 5P, 6P, 9P, 10P, 12P)	3	14 (6.4)
60 A (4P, 5P) w/top adders	3	14.2 (6.4)
100 A (2P, 3P)	4	39 (18)
100 A (4P, 5P, 6P, 9P)	4	67 (30)
200 A (2P, 3P)	10	117 (53)
200 A (4P, 5P, 6P)	10	140 (64)
300 A (2P, 3P)	10	120 (54)
300 A (4P, 5P, 6P)	10	143 (65)
400 A (2P, 3P)	10	132 (60)

Table 31.2-5. Type 3R, 4/4X, 12 Non-combination Lighting Contactors — Electrically Held — CN35

Ampere Size (Poles)	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Contactors — without Control Power Transformers		
10 A (2P, 3P, 4P, 5P, 6P)	5	12 (5.4)
10 A (9P, 10P, 12P, 20P)	7	20 (9.1)
20 A (2P, 3P, 4P, 5P)	5	12 (5.4)
20 A (6P)	5	14 (6.4)
20 A (9P, 10P, 12P, 20P)	7	20 (9.1)
30 A (2P, 3P, 4P)	5	13 (5.9)
30 A (5P, 6P)	6	14 (6.4)
30 A (9P, 10P, 12P, 20P)	7	20 (9.1)
60 A (2P, 3P, 4P)	5	13 (5.9)
60 A (5P, 6P)	6	16 (7.3)
60 A (9P, 10P, 12P)	7	22 (10)
100 A (2P, 3P)	8	49 (22)
100 A (4P, 5P, 6P, 9P)	8	57 (26)
200 A (2P, 3P)	8	110 (50)
300 A (2P, 3P)	10	113 (51)
400 A (2P, 3P)	10	125 57)
Non-reversing Contactors — with Control Power Transformers		
10 A (2P, 3P, 4P, 5P, 6P)	5	16 (7.3)
10 A (9P, 10P, 12P, 20P)	7	20 (9)
20 A (2P, 3P, 4P, 5P)	5	16 (7.3)
20 A (6P, 9P, 10P, 12P, 20P)	7	24 (11)
30 A (2P, 3P, 4P)	6	18 (8.2)
30 A (5P, 6P)	6	18 (8.2)
30 A (9P, 10P, 12P, 20P)	7	24 (11)
60 A (2P, 3P)	6	21 (10)
60 A (4P, 5P, 6P)	6	23 (10)
60 A (9P, 10P, 12P)	7	22 (10)
100 A (2P, 3P)	8	56 (25)
100 A (4P, 5P, 6P, 9P)	8	64 (29)
200 A (2P, 3P)	8	117 (53)
300 A (2P, 3P)	10	120 (54)
400 A (2P, 3P)	10	132 (60)

Table 31.2-6. Type 1 Combination Lighting Contactors

Ampere Size	Box No.	Shipping Wt. Lbs. (kg)
Electrically Held — Non-reversing (3P Only) — with or without Control Power Transformers		
30 A	A	35 (16)
60 A	A	36 (16)
100 A	C	65 (30)
200 A with Disconnect Switch	D	110 (50)
200 A with Thermal Magnetic Breaker	E	150 (68)
300 A	E	160 (73)
400 A	E	170 (77)

Table 31.2-7. Type 3R, 4/4X, 12 Combination Lighting Contactors

Ampere Size (Device)	Box No.	Shipping Wt. Lbs. (kg)
Electrically Held — Non-reversing (3P Only) — with or without Control Power Transformers		
30 A	A	35 (16)
60 A	A	36 (16)
100 A	C	65 (30)
200 A with Disconnect Switch	D	110 (50)
200 A ⑤	E	150 (68)
300 A	E	160 (73)
400 A	E	170 (77)

⑤ With thermal magnetic breaker.

For enclosure box dimensions, refer to Page 31.7-3.

Table 31.2-8. ac Magnet Coil Data

Description	Contactor Catalog Number/Size							
	CN35AN 10 A	**CN35BN 20 A**	**CN35DN 30 A**	**CN35GN 60 A**	**CN35KN 100 A**	**CN35NN 200 A**	**CN35SN 300 A**	**CN35TN 400 A**
Frame Size	45 mm	45 mm	45 mm	65 mm	90 mm	180 mm	180 mm	180 mm
ac Magnet Coil Data								
Pickup Volts — Cold	74%	74%	74%	74%	72%	75%	75%	75%
Pickup Volts — Hot	78%	78%	78%	78%	76%	77%	77%	77%
Pickup Voltamperes	100	100	100	230	390	1158	1158	1158
Pickup Watts	65	65	65	95	112	240	240	240
Sealed Voltamperes	10	10	10	28	49.8	100	100	100
Sealed Watts	3.1	3.1	3.1	7.8	13	27.2	27.2	27.2
Dropout Volts — Cold	45%	45%	45%	49%	50%	63%	63%	63%
Dropout Volts — Hot	46%	46%	46%	50%	52%	64%	64%	64%
Pickup Time (ms)	12	12	12	20	14	23	23	23
Dropout Time (ms)	12	12	12	14	11	15	15	15
Coil Operating Range	-15% to +10%							
Magnet Coil Data UL Listed Rating	Class 130 (B) — 105°C Temperature Rate							
Operating Temperature	-20° to +65°C							
Maximum Operating Altitude	6000							
Mechanical Life	20,000,000			10,000,000	6,000,000	5,000,000	5,000,000	5,000,000
Wire Range Power Terminals	12 – 16 Stranded, 12 – 14 Solid Cu	12 – 16 Stranded, 12 – 14 Solid Cu	8 – 16 Stranded 10 – 14 Solid Cu	3 – 14 (upper) &/or 6 – 14 (lower) Stranded or Solid Cu	1/0 – 14 Cu	350 kcmil – 6 Cu	350 kcmil – 8 Cu	600 kcmil – 2/0 Cu
Control Terminals	12 – 16 Stranded 12 – 14 Solid Cu							
Contact Kit Part No.								
2-Pole	N/A	N/A	N/A	6-65-7	6-43-5	6-44	6-45	6-45
3-Pole	N/A	N/A	N/A	6-65-8	6-43-6	6-44-2	6-45-2	6-45-2
Auxiliary Contact Rating	A600, P300 See **Page 31.2-5**							

Table 31.2-9. dc Magnet Coil Data

Description	Contactor Catalog Number/Size							
	CN35AN 10 A	**CN35BN 20 A**	**CN35DN 30 A**	**CN35GN 60 A**	**CN35KN 100 A**	**CN35NN 200 A**	**CN35SN 300 A**	**CN35TN 400 A**
Frame Size	45 mm	45 mm	45 mm	65 mm	90 mm	180 mm	180 mm	180 mm
Volts	24 V							
dc Magnet Coil Data								
Pickup Volts — Hot	80%	80%	80%	60%	61%	61%	61%	67%
Pickup Voltamperes	3.2	3.2	3.2	6.2	12.0	12.0	12.0	18
Pickup Watts	76.8	76.8	76.8	88.4	288.0	288.0	288.0	400.0
Sealed Voltamperes	.14	.14	.14	.21	.20	.20	.20	.22
Sealed Watts	3.36	3.36	3.36	4.96	4.75	4.75	4.75	5.3
Dropout Volts — Hot	60%	60%	60%	29%	22%	22%	22%	25%
Pickup Time (ms)	22	22	22	20	38	38	38	53
Dropout Time (ms)	17	17	17	13	14	14	14	14
Maximum Operating Altitude	3600							2400

- **UL Insulation Rating** — Class 130 (B), 105°C temperature rise.
- **Operational Limits** — 85 – 110% of rated voltage for ac coils and 80% – 110% of rated voltage for dc coils.

Coil Data Notes

P.U. = Pickup time is the average time taken from closing of the coil circuit to main contact touch.

D.O. = Dropout time is the average time taken from opening of the coil circuit to main contact separation.

Cold = Coil data with a cold coil.

Hot = Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 Vac or 24 Vdc magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

Type C30CNM — Open (ECC — Enclosed)

C30CNM

Product Description

The Cutler-Hammer C30CNM 30 ampere Mechanically Held Lighting Contactors by Eaton are designed for industrial, commercial and outdoor lighting applications where efficient control is required. The mechanically held operation ensures that the contactor will not switch to OFF during control power failure. It also ensures the removal of coil from the circuit for noise-free operation and the elimination of all coil losses after the contactor is latched. The control module microprocessor validates the control signal before operation, so it will not respond to momentary voltage spikes of noise. The operation command has a built-in .4 second delay to avoid multiple short-term commands that can cause contact fatigue or failure. Also, the feedback loop prevents the contactor from getting out of sequence with switches, even after power failures.

Typical Specifications

Mechanically-held lighting contactors are Cutler-Hammer Type C30CNM or approved equal and are rated for lighting loads of 30 amperes. They are capable of being supplied in a 2 – 12 pole single unit configuration.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. The contactor is capable of being operated such that it will not switch to OFF during control circuit power failures.

Operation

3-wire control is the choice for use with momentary devices allowing operation from multiple locations. A momentary pulse of energy operates the contactor while a second pulse on an alternate leg returns the contactor to its original state.

2-wire control is the choice for single output automatic operation or for operation from single-pole devices. When voltage is applied to the input terminals the contactor is latched into position (coil is removed from the circuit while control voltage is continuously supplied). When control voltage is removed, the latch is disengaged and the contactor is returned to its original state.

Technical Data and Specifications

Main Power Poles

Table 31.2-10. Maximum ac Voltage and Ampere Ratings

Load Type	Amps Continuous	Poles	
		1-Phase	3-Phase
Ballast	30	347 Vac	600 Vac
General Use	30	600 Vac	600 Vac
Tungsten	20	277 Vac	480 Vac
ac Resistive	30	600 Vac	600 Vac

Table 31.2-11. Maximum Horsepower Rating

Normal Starting Duty	
Volts	Horsepower
1-Pole, Single-Phase	
110 – 120	1
220 – 240	2
3-Pole, Three-Phase	
200 – 208	3
220 – 240	5
440 – 480	10
550 – 600	15

Table 31.2-12. Control Module

Input Voltage	Steady-State Current at Rated Voltage (mA)	Maximum VA
12 – 24 Vdc	42	2
24 Vac	80	5
115 – 120 Vac	83	12
200 – 277 Vac	91	30

Table 31.2-13. Other Control Module Characteristics

Description	Specification
Minimum Pulse Duration (3-Wire Control Module)	250 ms
Maximum Allowable Leakage Current	1.8 mA
EMI	35 V/m
Surge Transient Peak	6 kV
Frequency Range	40 – 70 Hz

Auxiliary Contacts Rating:

- 600 amperes, 24 Vdc, 24 VA.

Ambient Temperature:

- -13 to 104°F (-25 to 40°C).

Mounting Position:

- Vertical 3-point mounting only.

Coil:

- Inrush 248 VA.
- Sealed 28 VA.

Wire Size

Table 31.2-14. Wire Specifications

Component	Number of Cables	Wire Range (Solid or Stranded)	Wire Temp.
Power Poles	1	14 – 8 AWG	75°C Cu
	2	14 – 8 AWG ①	75°C Cu
Coil	1 or 2	18 – 14 AWG	60°/75°C Cu
Control Module	1	22 – 12 AWG	60°/75°C Cu
Auxiliary Contacts	1 or 2	22 – 12 AWG	60°/75°C Cu

① 8 AWG stranded only.

Enclosed Box Selection

Table 31.2-15. Type 1 Non-combination Lighting Contactors — C30CN ②

Ampere Size (Poles)	Box No.	Shipping Wt. Lbs. (kg)
Lighting Contactors — without Control Power Transformers		
30 A (2 – 12)	2	9 (4.1)
Lighting Contactors — with Control Power Transformers		
30 A (2 – 12)	3	13.5 (5.9)

② Consult factory for combination enclosures.

Table 31.2-16. Type 3R, 4X and 12 Non-combination Lighting Contactors — C30CN ③

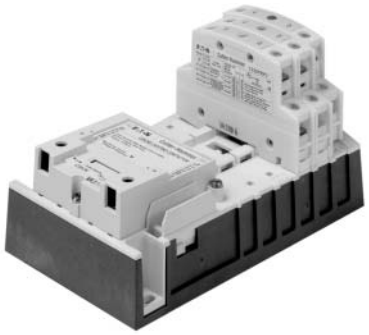
Ampere Size (Poles)	Box No.	Shipping Wt. Lbs. (kg)
Lighting Contactors — without Control Power Transformers		
30 A (2 – 12)	6	14 (6.4)
Lighting Contactors — with Control Power Transformers		
30 A (2 – 12)	7	20 (9.1)

③ Consult factory for combination enclosures.

For enclosure box dimensions, refer to Page 31.7-3.

Components

Electrically Held Base Contactor



Electrically Held Base Contactor

The C30CNE20_0 Electrically Held Base Contactor contains a 2NO power pole as standard and will allow the addition of power poles to build an Electrically Held Contactor up to 12 poles maximum. A Mechanically Held Module Kit can also be added to convert the Electrically Held Contactor into a Mechanically Held Contactor in the field.

Table 31.2-17. Electrically Held Base Contactor

Power Poles	Catalog Number ①
2NO	**C30CNE200**

① When ordering, select required contactor by Catalog Number and replace the magnet coil alpha designation in the Catalog Number (...) with the proper Code Suffix from **Table 31.2-18**.

Table 31.2-18. Coil Base Voltage (Digit 8)

Voltage (Digit 8)	Code Suffix
115 – 120 Volt 60 Hz/110 Volt 50 Hz	A
230 – 240 Volt 60 Hz/220 Volt 50 Hz	B
460 – 480 Volt 60 Hz/440 Volt 50 Hz	C
575 – 600 Volt 60 Hz/550 Volt 50 Hz	D
200 – 208 Volt 60 Hz	E
265 – 277 Volts 60 Hz/240 Volt 50 Hz	H
24 Volt 60 Hz/20 Volt 50 Hz	T
28 Volt 60Hz/24 Volt 50 Hz	V
347 Volt 60 Hz	X

Power Poles

Power Poles

The C30CNM contactor accepts up to a maximum 6 single- or double-pole (or combinations) power poles. These can be used to form up to:

- 12NO poles maximum when 6 double-poles are used in NO positions (1 – 6) or.
- 8NC poles maximum with 4 double-poles in the NC position (1 – 4) and 4NO poles with 2 double-poles in the 2NO positions (5 – 6)

Table 31.2-19. Power Poles

Power Poles	Catalog Number
Single-Pole	**C320PRP1**
Double-Pole	**C320PRP2**

Mechanically Held Module Kits

Conversion Kits

These kits are for converting electrically held contactors to mechanically held units. Kits include control module, latch, latch cover and auxiliary contacts plus installation instructions. Conversion kits are suitable for coil voltages of 277 volts and below.

Table 31.2-20. Table 9. Mechanically Held Module Kits

Coil Volts	Control Volts	Catalog Number
2-Wire		
24 – 277 Vac	110 – 120 Vac	**C320MH2WA0**
	200 – 277 Vac	**C320MH2WH0**
	24 Vac	**C320MH2WT0**
	12 – 24 Vdc	**C320MH2WT1**
3-Wire		
24 – 277 Vac	110 – 120 Vac	**C320MH3WA0**
	200 – 277 Vac	**C320MH3WH0**
	24 Vac	**C320MH3WT0**
	12 – 24 Vdc	**C320MH3WT1**

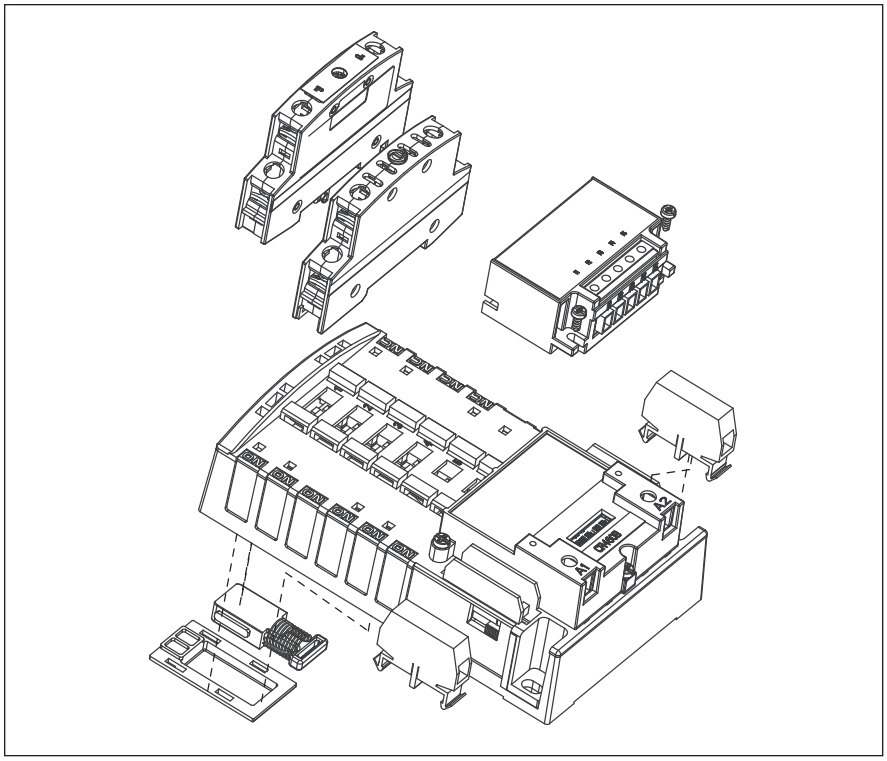


Figure 31.2-4. C30CNM Components — Exploded View

Auxiliary Contacts

Auxiliary Contacts

A Mechanically Held Contactor with a 2-wire control module uses 1NC auxiliary contact as standard for the control wiring circuit. The Mechanically Held Contactor with a 3-wire control module uses 1NO-1NC auxiliary contacts as standard for the control wiring circuit. See **Table 31.2-21** for possible additional auxiliary contact configurations.

Table 31.2-21. Auxiliary Contact Configurations

2-Wire	3-Wire
None 1NO (single-pole) 2NO (double-pole)	None 1NC (double-pole) 1NO (double-pole)
1NC (double-pole) 1NO-1NC (NO single-pole, NC double-pole) 2NO-1NC (double pole)	1NO – 1NC (double-pole) — —

Table 31.2-22. Auxiliary Contact Blocks

Auxiliary Block	Catalog Number
Single-Pole Double-Pole	**C320AMH1** **C320AMH2**

Replacement Parts

Magnetic Coils for the Base Contactor

Magnetic Coils

Table 31.2-23. Magnetic Coils

Coil Voltage	Catalog Number
115 – 120 Volt 60 Hz/110 Volt 50 Hz	**9-3242-1**
230 – 240 Volt 60 Hz/220 Volt 50 Hz	**9-3242-2**
460 – 480 Volt 60 Hz/440 Volt 50 Hz	**9-3242-3**
575 – 600 Volt 60 Hz/550 Volt 50 Hz	**9-3242-4**
200 – 208 Volt 60 Hz	**9-3242-5**
265 – 277 Volt 60 Hz/240 Volt 50 Hz	**9-3242-6**
24 Volt 60 Hz/20 Volt 50 Hz	**9-3242-7**
28 Volt 60 Hz/24 Volt 50 Hz	**9-3242-8**
347 Volt 60 Hz	**9-3242-9**

31

Wiring Diagrams

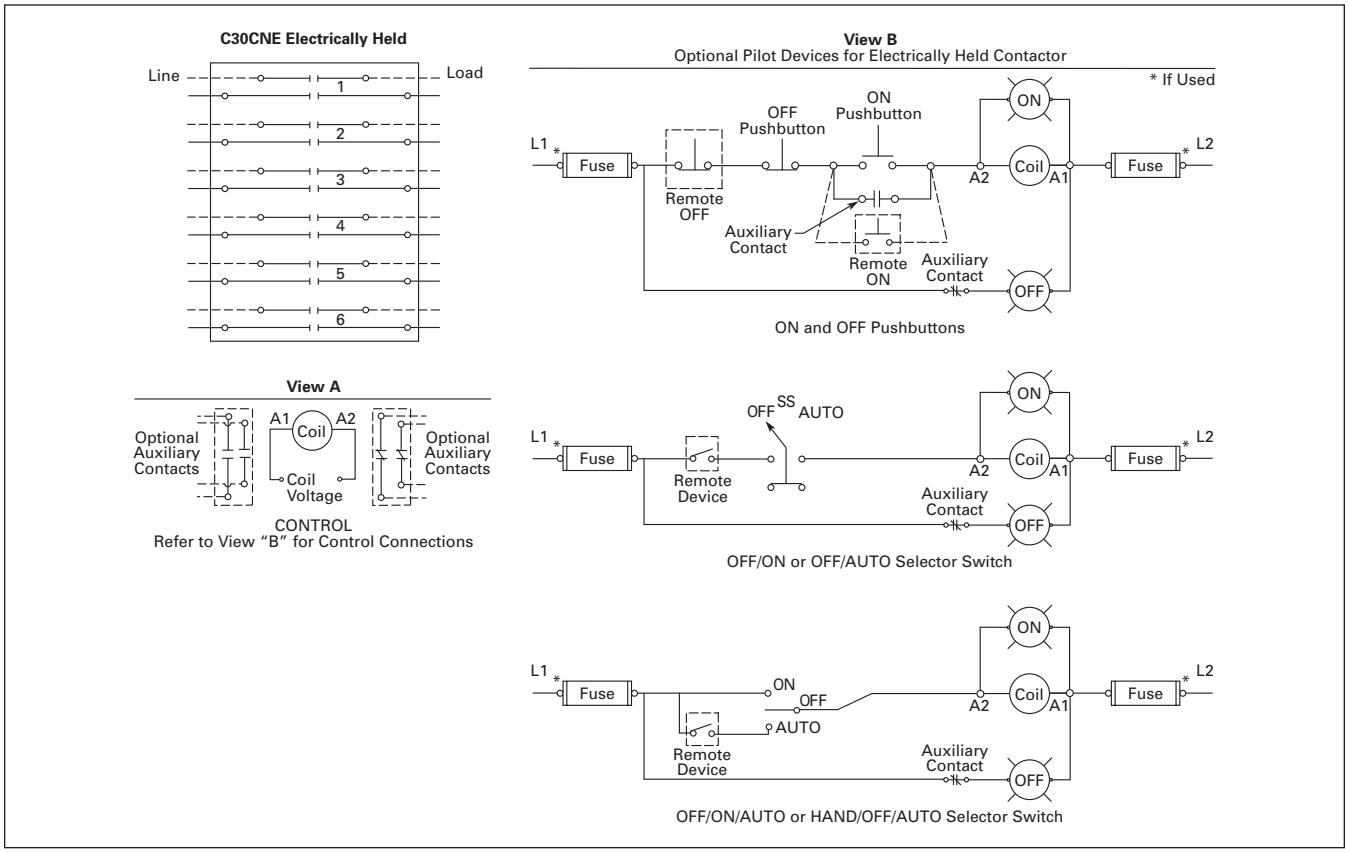


Figure 31.2-5. C30CNM Wiring Diagram

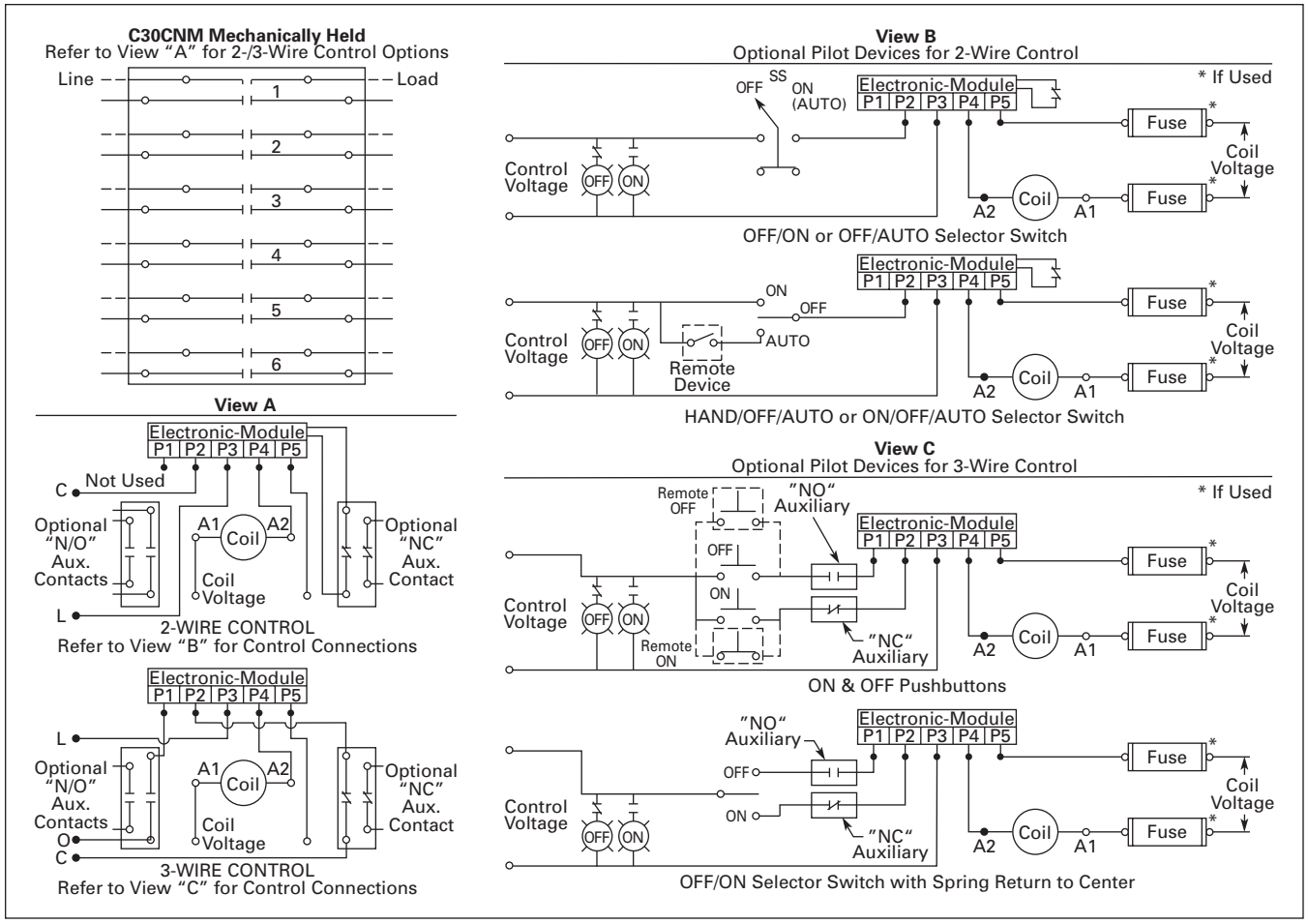


Figure 31.2-6. C30CNM Wiring Diagram

Dimensions

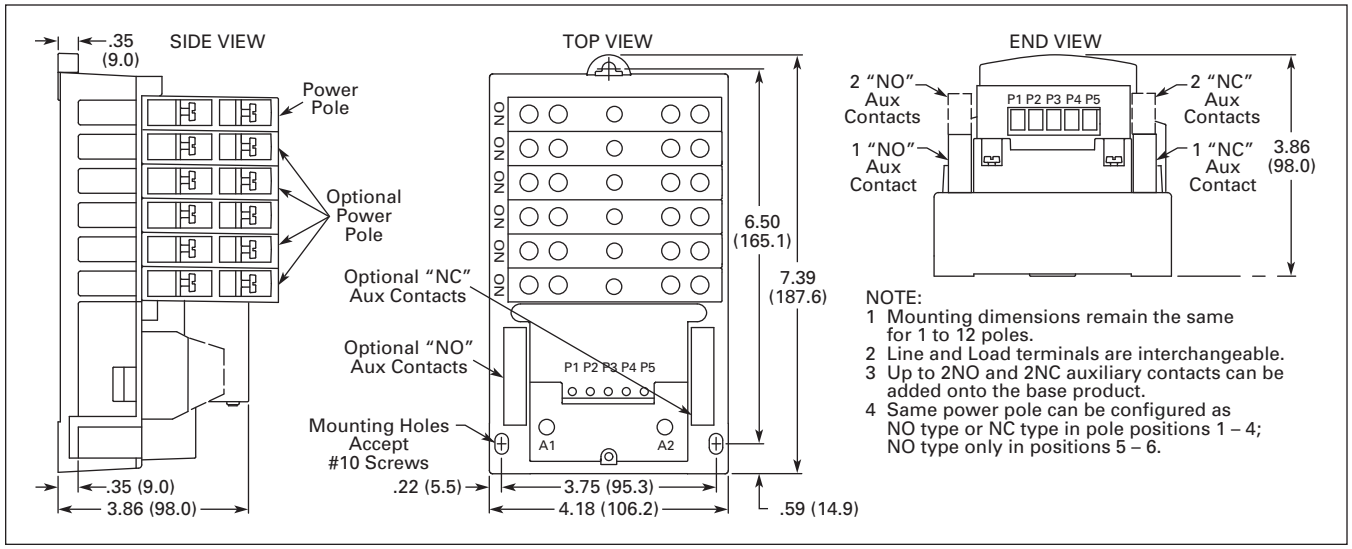
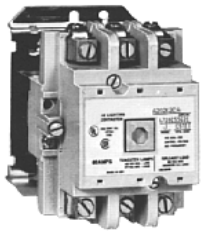

SIDE VIEW
.35 (9.0)
Power Pole
Optional Power Pole
Optional "NC" Aux Contacts
Optional "NO" Aux Contacts
Mounting Holes Accept #10 Screws
.35 (9.0)
3.86 (98.0)
TOP VIEW
NO
P1 P2 P3 P4 P5
A1
A2
6.50 (165.1)
7.39 (187.6)
.22 (5.5)
3.75 (95.3)
4.18 (106.2)
.59 (14.9)
END VIEW
2 "NO" Aux Contacts
1 "NO" Aux Contact
2 "NC" Aux Contacts
1 "NC" Aux Contact
3.86 (98.0)
NOTE:
1 Mounting dimensions remain the same for 1 to 12 poles.
2 Line and Load terminals are interchangeable.
3 Up to 2NO and 2NC auxiliary contacts can be added onto the base product.
4 Same power pole can be configured as NO type or NC type in pole positions 1 – 4; NO type only in positions 5 – 6.

Figure 31.2-7. Approximate Dimensions in Inches (mm)

A202–Open (ECL04–Enclosed)



60 Ampere Size

Product Description

AC lighting contactors provide a safe convenient means for local or remote switching of relatively large tungsten, fluorescent or mercury arc lamp loads. They are also suitable for low pressure and high pressure sodium lamp loads.

These lighting contactors are designed to withstand the large initial inrush currents of tungsten lamp loads without contact welding. They are full rated and do not require derating as do standard motor control contactors.

Operation (Magnetic Latch)

A permanent magnet is built into the contactor structure that will maintain the contactor in its energized state indefinitely without using control power. When energized, a dc current is applied to the latch coil producing a magnetic field that reinforces the polarity of the permanent magnet, pulling in the contactor. The current to the coil is disconnected by the coil clearing interlock. In order to drop-out the contactor, it is necessary to apply a field through the STOP coil in the reverse direction to the permanent magnet. This momentarily cancels the magnetic attraction and the contactor drops out.

Enclosures

Open and NEMA Types 1, 3R, 4X and 12.

Specifications

- Terminals:
  - All except 30-ampere devices . . . . . Al/Cu
  - 30-ampere devices . . . . . Cu only
- Ballast load 600 Vac, breaking all lines.
- Tungsten lamp loads, maximum volts:
  - Line-to-line. . . . . 480 Vac
  - Line-to-neutral. . . . . 277 Vac

Typical Specifications

Magnetically-held lighting contactors are Eaton's Cutler-Hammer Type A202 or approved equal for lighting loads of 30 – 400 A. Magnetically-held combination lighting contactors are Cutler-Hammer Type ECL15 (breaker) or ECL13 (fusible) or approved equal for loads of 30 – 200 A when integral short circuit protection is required.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contacts welding. The contactors are capable of being "magnetically held" via a magnetic latch design utilizing a permanent magnet. The contactor shall be operated by a RUN signal and a STOP signal preventing the contactor from switching to "OFF" during control circuit power failures.

Table 31.2-24. Ratings — Latched ac Lighting Contactors

Holding Circuit Auxiliary Contact or Pushbutton Station not Included	
Continuous Amperes (Enclosed)	**Number of Poles**
30	2, 3, 4, 5, 6, 8, 10, 12
60	2, 3, 4, 5, 6, 8, 10, 12
100	2, 3, 4, 5, 6, 8, 10, 12
200	2, 3, 4, 5, 6, 8, 10, 12
300	2, 3
400	2, 3

Table 31.2-25. Non-Combination Lighting Contactors — 6 to 12 Pole

Continuous Amperes (Enclosed)	Number of Poles	Pole Configuration	Dimensions in Inches (mm)	
			Open Type	
			Wide A	High B
30	6	3 x 3	7.13 (181.1)	4.46 (113.3)
	8	4 x 4	7.13 (181.1)	4.46 (113.3)
	10	5 x 5	10.63 (270.0)	4.46 (113.3)
	12	4 x 4 x 4	12.38 (314.5)	6.88 (174.8)
60	6	3 x 3	7.13 (181.1)	4.46 (113.3)
	8	4 x 4	10.63 (270.0)	4.46 (113.3)
	10	5 x 5	10.63 (270.0)	4.46 (113.3)
	12	5 x 5 x 2	15.00 (381.0)	6.88 (174.8)
100	6	3 x 3	9.75 (247.7)	6.88 (174.8)
	8	5 x 3	12.38 (314.5)	6.88 (174.8)
	10	5 x 5	15.00 (381.0)	6.88 (174.8)
	12	5 x 5 x 2	34.13 (866.9)	27.50 (698.5)
200	6	3 x 3	9.75 (247.7)	6.88 (174.8)
	8	5 x 3	12.38 (314.5)	6.88 (174.8)
	10	5 x 5	15.00 (381.0)	6.88 (174.8)
	12	5 x 5 x 2	34.13 (866.9)	27.50 (698.5)

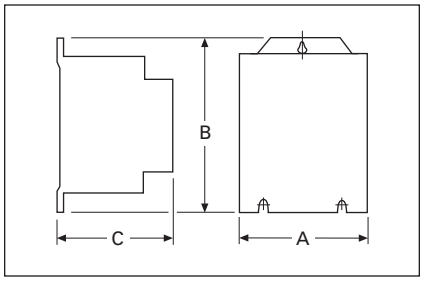


Figure 31.2-8. Open Type

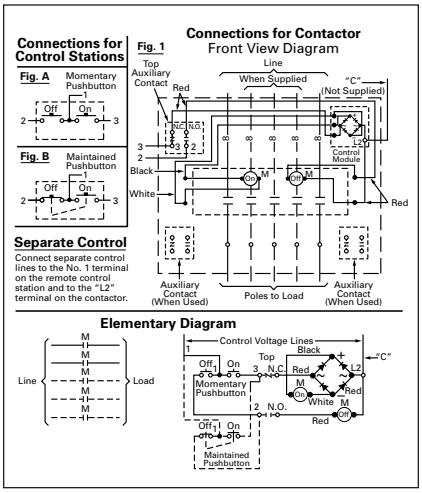


Figure 31.2-9. Connection Diagram

Enclosed Box Selection

Table 31.2-26. Type 1 Non-combination Lighting Contactors — Magnetically Latched — A202

Ampere Size (Poles)	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Contactors— without Control Power Transformers		
30 A (2P, 3P, 4P, 5P)	2	8.5 (3.9)
30 A (6P, 8P, 10P, 12P)	3	13 (5.9)
30 A (20P)	4	35 (16)
60 A (2P, 3P, 4P, 5P)	2	8.7 (3.9)
60 A (6P, 8P, 10P, 12P)	3	13.5 (6.1)
60 A (20P)	4	40 (18)
100 A (2P, 3P, 4P, 5P)	4	40 (18)
100 A (6P, 8P, 10P, 12P)	9	85 (39)
100 A (20P)	9	100 (45)
200 A (2P, 3P, 4P, 5P)	4	46 (21)
200 A (6P, 8P, 10P, 12P)	9	95 (43)
200 A (20P)	9	110 (50)
300 A (2P, 3P)	10	115 (52)
400 A (2P, 3P)	10	125 (57)
Non-reversing Contactors — with Control Power Transformers		
30 A (2P, 3P, 4P, 5P)	2	12.5 (5.7)
30 A (6P, 8P, 10P, 12P)	3	17 (7.7)
30 A (20P)	4	39 (18)
60 A (2P, 3P, 4P, 5P)	2	12.7 (5.8)
60 A (6P, 8P, 10P)	3	17.5 (7.9)
60 A (12P)	9	87 (39)
100 A (20P)	4	44 (20)
100 A (2P, 3P, 4P, 5P)	4	47 (21)
100 A (6P, 8P, 10P, 12P)	9	92 (42)
200 A (20P)	9	107 (49)
200 A (2P, 3P, 4P, 5P)	4	53 (24)
200 A (6P, 8P, 10P, 12P)	9	102 (46)
300 A (20P)	9	117 (53)
400 A (2P, 3P)	10	122 (55)
30 A (2P, 3P)	10	132 (60)

Table 31.2-27. Type 3R, 4/4X, 12 Non-combination Lighting Contactors — Magnetically Latched — A202

Ampere Size (Poles)	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Contactors — without Control Power Transformers		
30 A (2P, 3P, 4P, 5P)	5	13 (5.9)
30 A (6P, 8P, 10P, 12P)	7	21 (10)
30 A (20P)	8	46 (21)
60 A (2P, 3P, 4P, 5P)	5	14 (6.4)
60 A (6P, 8P, 10P, 12P)	7	22 (10)
60 A (20P)	8	48 (22)
100 A (2P, 3P, 4P, 5P)	8	50 (23)
100 A (6P, 8P, 10P,12P)	9	58 (26)
100 A (20P)	10	100 (45)
200 A (2P, 3P, 4P, 5P)	8	52 (24)
200 A (20P)	10	105 (48)
300 A (2P, 3P)	10	113 (51)
400 A (2P, 3P)	10	125 (57)
Non-reversing Contactors — with Control Power Transformers		
30 A (2P, 3P)	6	15 (6.8)
30 A (4P, 5P, 6P, 8P, 10P, 12P)	7	28 (13)
30 A (20P)	8	54 (25)
60 A (2P, 3P)	6	16 (7.3)
60 A (4P, 5P, 6P, 8P, 10P, 12P)	7	29 (13)
60 A (20P)	8	55 (25)
100 A (2P, 3P, 4P, 5P)	8	57 (26)
100 A (6P, 8P, 10P, 12P)	9	65 (30)
100 A (20P)	10	112 (51)
200 A (2P, 3P, 4P, 5P)	8	59 (27)
300 A (2P, 3P)	10	120 (54)
400 A (2P, 3P)	10	132 (60)

Table 31.2-28. Type 1 Combination Lighting Contactors

Ampere Size	Box No.	Shipping Wt. Lbs. (kg)
Magnetically Latched — Non-reversing (3P Only) — with or without Control Power Transformers		
30 A	A	35 (16)
60 A	A	36 (16)
100 A	C	65 (30)
200 A with Disconnect Switch	D	110 (50)
200 A with Thermal Magnetic Breaker	E	150 (68)
300 A	E	140 (64)
400 A	E	190 (86)

Table 31.2-29. NEMA 3R, 4/4X, 12 Combination Lighting Contactors

Ampere Size (Device)	Box No.	Ship Wt. Lbs.
Magnetically Latched — Non-Reversing (3P Only) — with or without Control Power Transformers		
30 A	A	35
60 A	A	36
100 A	C	65
200 A with Disconnect Switch	D	110
200 A with Thermal Magnetic Breaker	E	150
300 A	E	
400 A	E	

For enclosure box dimensions, refer to Page 31.7-3.

Combination Lighting Contactors

Types ECL12, ECL13, ECL14 and ECL15

Product Description

Catalog Number ECL12, ECL13, ECL14 and ECL15 combination lighting contactors offer convenient installation of switching and overcurrent protection in a single enclosure. Combination lighting contactors are ideally suited for industrial and commercial lighting applications or where a lighting circuit may have to be disconnected for periodic maintenance. They may also be applied on resistance heating loads.

Typical Specifications

Magnetically latched combination lighting contactors are Eaton's Cutler-Hammer Type ECL15 (breaker) or ECL13 (fusible) or approved equal for loads of 30 – 200 A when integral short circuit protection is required.

These contactors are designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. The contactors are capable of being "magnetically held" via a magnetic latch design utilizing a permanent magnet. The contactor shall be operated by a RUN signal and a STOP signal preventing the contactor from switching to "OFF" during control circuit power failures.

Electrically-held combination lighting contactors are Cutler-Hammer Type ECL14 (breaker) or ECL12 (fusible) or approved equal for loads of 30 – 400 A when integral short circuit protection is required.

These contactors shall be designed to withstand the large initial inrush currents of tungsten and ballast lamp loads as well as non-motor (resistive) loads without contact welding. Contactors shall be capable of accepting up to 8 auxiliary contacts — top and/or side up to 60 amperes and side only up to 400 amperes. Contactors shall be capable of being operated by ac or dc control.

Features

- Disconnect devices — either a Series C circuit breaker or a fusible disconnect switch.
- Handle mechanism — flange mounted.
- UL® listed.
- UL service entrance approved for
- NEMA 3R outdoor enclosure.
- Extra room for modifications such as a 24-hour time clock.

Catalog Number Selection

Table 31.2-30. Enclosed Lighting Contactor Catalog Numbering System

EC L 12 D 1 A 3 E - X

Design
L = CN35 or A202 Lighting Contactor
C = C30CN Lighting Contactor

Class
Non-combination Contactors
03 = Electrically Held
04 = Mechanically/Magnetically Latched
Combination — Fusible
12 = Electrically Held
13 = Mechanically/Magnetically Latched
Combination — Thermal-Magnetic Circuit Breaker
14 = Electrically Held
15 = Mechanically/Magnetically Latched

Ampere Size ①

A = 10 A	**F** = 200 A
B = 20 A	**G** = 300 A
C = 30 A	**H** = 400 A
D = 60 A	**J** = 600 A
E = 100 A	

Enclosure Types
1 = Type 1 — General Purpose
2 = Type 3R — Rainproof
3 = Type 4 — Watertight (Painted)
4 = Type 4X — Watertight (304-Grade Stainless Steel)
6 = Type 7/9 — Explosion Proof
8 = Type 12 — Dust-Tight
9 = Type 4X — Watertight (316-Grade Stainless Steel)

Number of Poles
1, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9** = Poles Required
A = 10 Poles
B = 12 Poles
C = 20 Poles
Combination Devices = 3-Pole Only

Coil Voltage

A = 120/60 110/50	**K** = 240/50	**T** = 24/60
B = 240/60 220/50	**L** = 380/50	**U** = 24/50
C = 480/60 440/50	**M** = 415/50	**V** = 32/50
D = 600/60 550/50	**P** = 12 Vdc	**W** = 48/60
E = 208/60	**Q** = 24 Vdc	**X** = 104 – 120/60
G = 550/50	**R** = 48 Vdc	**Y** = 48/50
H = 277/60	**S** = 125 Vdc	**Z** = By Description
J = 208 – 240/60		

Modification Codes
(See PG03300001E)

Disconnect Fuse Clip Ratings

A = None	**J** = 200 A/600 V R
B = 30 A/250 V R	**K** = 400 A/250 V R
C = 30 A/600 V R	**L** = 400 A/600 V R
D = 60 A/250 V R	**M** = 600 A/250 V R
E = 30 A/600 V R	**N** = 600 A/600 V R
F = 100 A/250 V R	**P** = 800 A/600 V R
G = 100 A/600 V R	**T** = By Description
H = 200 A/250 V R	

Thermal-Magnetic Breaker Ratings

A = None	**F** = 60 A	**J** = 300 A	**M** = 800 A
D = 20 A	**G** = 100 A	**K** = 400 A	**T** = By Description
E = 30 A	**H** = 200 A	**L** = 600 A	

① C30CN available in 30A only.

Table 31.2-31. Ratings — Latched ELC15 Series C Circuit Breaker Disconnect

Continuous Amperes (Enclosed)	Circuit Breaker	
	Ampere Rating	System Voltage
30	30	600
60	60	600
100	100	600
200	200	600

Table 31.2-32. ELC13 — Fusible Disconnect Switch

Continuous Amperes (Enclosed)	Fuse Clip	
	Ampere Rating	System Voltage
30	30	250, 600
60	60	250, 600
100	100	250, 600
200	200	250, 600

Table 31.2-33. Ratings — Electrically-held ELC14 Series C Circuit Breaker Disconnect

Continuous Amperes (Enclosed)	Circuit Breaker	
	Ampere Rating	System Voltage
30	30	600
60	60	600
100	100	600
200	200	600
300	300	600
400 ①	400	600

① UL ballast and resistive ratings only.

Table 31.2-34. ELC12 — Fusible Disconnect Switch

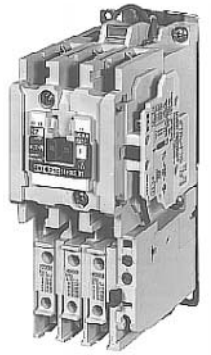
Continuous Amperes (Enclosed)	Fuse Clip	
	Ampere Rating	System Voltage
30	30	250, 600
60	60	250, 600
100	100	250, 600
200	200	250, 600
300	300	250, 600
400 ②	400	250, 600

② UL ballast and resistive ratings only.

Table 31.2-35. Factory Modifications

Description	Enclosure	Used On	
		Standard	Combination
Control Transformers:	Any		
480 to 120 V Control Transformer		X	X
100 VA Extra Capacity Transformer		X	X
200 VA Extra Capacity Transformer		X	X
240 to 120 V Control Transformer with Fuse in Holder		X	X
208 to 120 V Control Transformer with Fuse in Holder		X	X
415 to 110 V Control Transformer with Fuse in Holder		X	X
277 to 120 V Control Transformer with Fuse in Holder		X	X
Lightning Arrester	Any	—	—
Undervoltage Relay		—	—
On-Off Pushbutton		X	X
Hand-Off-Auto Selector Switch		X	X
Addition of Photoelectric Receptacle and Relay with Photo Cell Installed (2-wire circuit)	—	X	X
24-Hour Time Clock, 120 V	—	X	X
24-Hour Time Clock with Day Omission, 120 V		X	X
7-Day Time Clock, 120 V		X	X
Cover Plate for Use in Place of Watertight Hub on Enclosure Top		X	X

NEMA Motor Starters Freedom Type



NEMA AN16DN0AB
NEMA Size 1

Product Description

The "Freedom Series" starters and contactors listed in this catalog feature a compact, space-saving design, using state-of-the-art technology and the latest in high strength, impact and temperature-resistant insulating materials. Starters and contactors are available in the NEMA (National Electrical Manufacturers' Association) style. The NEMA devices are sized based on traditional NEMA classifications.

Application Description

The Freedom to Choose the Right Product for the Application

Eaton has been supplying quality industrial control products for more than 100 years — the Freedom Series of Contactors and Starters continue in this tradition. They offer something no other electrical control line in the world can — the "Freedom" to choose contactors and starters designed to NEMA standards. There are many difficult choices to be made today in matching electrical control to a specific application, but the Cutler-Hammer Freedom Series makes it easy.

Features

Freedom Family

- A single family of contactors and starters suitable for applications in NEMA markets.
- Adjustable Bimetallic Ambient Compensated Overload relays with interchangeable heater packs — available in three basic sizes, covering applications up to 900 hp — reducing the number of different contactor/overload relay combinations that have to be stocked.
- A full line of snap-on accessories — top and side mounted auxiliary contacts, solid-state and pneumatic timers, etc.
- Straight-through wiring — line lugs at top, load lugs at bottom.
- Horizontal or vertical mounting on upright panel for application freedom.
- Screw type power terminals have captive, backed-out self-lifting pressure plates with ± screws — reduced wiring time.
- Accessible terminals for easy wiring. Optional fingerproof shields available to prevent electrical shock.
- Top located coil terminals convenient and readily accessible. 45 mm contactor magnet coils have three terminals, permitting either top or diagonal wiring — easy to replace starters or contactors without changing wiring layout.
- Encapsulated dual voltage/frequency magnet coils — permanently marked with voltage, frequency and part number. NEMA Sizes 00 – 0 have non-encapsulated coils as standard.
- Designed to meet or exceed NEMA, UL and CSA.

Freedom NEMA

Freedom NEMA contactors and starters are designed to NEMA standards and are extremely rugged products and built for any application. Their long electrical/mechanical life is extended through easy maintainability.

- Meet and exceed all NEMA, UL and CSA® standards.
- Sized based on standard NEMA classifications.
- Designed and built for a variety of demanding applications.
- Easy coil change and inspectable/replaceable contacts.
- Adjustable/interchangeable heater packs for flexibility.
- Available in Open and NEMA 1, 3R, 4/4X and 12 enclosures.

Freedom Enhancements

65 mm Contactor

Accessible Power Terminations to Facilitate Installation

The 65 mm contactor housing has been completely redesigned to open up the line/load terminal access area, allowing better visibility when wiring. This also aids in maintenance. IP20 fingerproofing is available through add-on shields. This change affects NEMA Sizes 1 and 2.

Load Lugs on Overload Relay Base

The load lugs have been moved from the heater pack housing to the sensor base of the 32 A and 75 A overload relays. This permits wiring of the starter prior to heater pack installation. These overload relays are used on NEMA Sizes 00 – 2 and 5 – 8.

Auxiliary Contact Markings

CENELEC EN50012 — All auxiliary contact blocks are identified by a two-digit contact configuration code. Auxiliary contact terminals are also identified by a two-digit number in accordance with International Standards approved by CENELEC.

Auxiliary Contact Ratings

All side and top auxiliary contact blocks are now rated NEMA/UL P300 dc ratings.

New Class 10 and 20 Heater Packs

Because of improvements in the overload relays, the Class 10 and 20 interchangeable heater packs have been modified. They can be used with the new overload relays (Series B1) directly or with the existing relays (Series A1) when using an adapter lug kit.

Series B1 32 A Overload

Easy Magnet Coil Change

The 65 mm contactor and the connections on the 45 and 65 mm starters have been modified to allow easy coil changes at the distributor or in the field.

Standards and Certifications

- Standard: Designed to meet or exceed UL, NEMA and CSA.
- UL listed: UL File #E1491, Guide #NLDX — Open; UL File #E176513 — Enclosed Combination Motor Controllers; UL File #E19224 — Enclosed Non-Combination Motor Controllers; UL File #E195239 — Enclosed Power Conversion Equipment.
- CSA certified: CSA File #LR353, Class #321104 Open and NEMA 1 Enclosed.

Certified Type 2 Coordination

Cutler-Hammer Freedom Series NEMA starters are now UL certified to achieve IEC 947 Type 2 coordination against 100,000 A short circuit fault currents. Any brand of properly selected fuse can be used. Type 2 coordination means that the starter will be suitable for further use following a short circuit fault.

ISO 9000 Certification

When you turn to Eaton's Cutler-Hammer products, you turn to quality. The International Standards Organization (ISO®) has established a series of standards acknowledged by 91 industrialized nations to bring harmony to the international quest for quality. The ISO certification process covers 20 quality system elements in design, production and installation that must conform to achieve registration. This commitment to quality will result in increased product reliability and total customer satisfaction.

Short Circuit Protection

Fuses and Inverse-Time Circuit Breakers may be selected per Article 430, Part D of the National Electrical Code to protect motor branch circuits from fault conditions. If higher ratings or settings are required to start the motor, do not exceed the maximum as listed in Exception No. 2, Article 430-52.

Contactor Terminal Markings

Contactors are identified by a two digit number in accordance with International Standards approved by CENELEC (European Committee for Electrotechnical Standardization). This distinctive number is marked on the top nameplate and designates the type and quantity of built-in auxiliary contacts. The first digit indicates the quantity of NO and the second digit indicates the quantity of NC contacts. **Example:** 10E indicates a contactor with 1NO and no NC auxiliary contacts factory supplied. In addition, all terminals conform to both CENELEC and NEMA requirements. Auxiliary contact terminals use the first digit to indicate location and the second digit to indicate status (1-2 means NC and 3-4 means NO). **Example:** 13-14 indicates the first auxiliary contact and it is a NO.

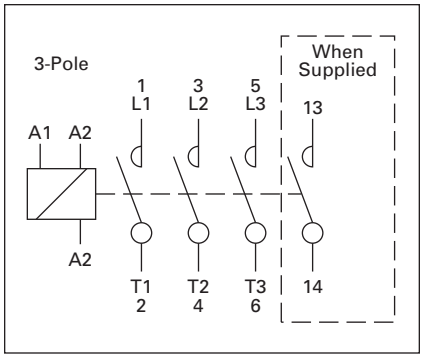


Figure 31.3-1. Contact Example

NEMA Sizes 00-8

Table 31.3-1. ac Coil Data

NEMA Sizes	Motor Voltage	Maximum hp Rating	P.U. Volts		P.U.			Sealed			D.O. Volts		Maximum Operation Rate Operations/Hour	P.U. Time ms	D.O. Time ms
			Cold	Hot	Var	VA	Watts	Var	VA	Watts	Cold	Hot			
00	200 230 460 575	1-1/2 1-1/2 2 2	74%	78%	64	80	49	7.1	7.5	2.4	45%	46%	12,000	12	12
0	200 230 460 575	3 3 5 5	74%	78%	78	100	65	9.2	10	3.1	45%	46%	12,000	12	12
1	200 230 460 575	7-1/2 7-1/2 10 10	74%	78%	210	230	95	27	28	7.8	49%	50%	12,000	20	14
2	200 230 460 575	10 15 25 25	74%	78%	210	230	95	27	28	7.8	49%	50%	12,000	20	14
3	200 230 460 575	25 30 50 50	72%	76%	374	390	112	48	49.8	13	50%	52%	7,200	14	11
4	200 230 460 575	40 50 100 100	73%	76%	1132	1158	240	96	100	27.2	54%	56%	2,400	28	14
5	200 230 460 575	75 100 200 200	75%	77%	1132	1158	240	96	100	27.2	63%	64%	2,400	25	13
6	200 230 460 575	150 200 400 400	75%	75%	868	1600	1345	11	25	22	①	①	N/A	105	200
7	230 460 575	300 600 600	75%	75%	868	1600	1345	11	25	20	①	①	N/A	105	200
8	230 460 575	450 900 900	75%	75%	1262	2450	2060	56	75	60	①	①	N/A	70	50

① 20 – 30% of rated coil voltage.

General Coil Data

- **Coil Offering** — tape wound:
  - NEMA Sizes 00 – 0
  - UL Insulation Rating: Class 130 (B)
- **Coil Offering** — encapsulated:
  - NEMA Sizes 1 – 3
  - UL Insulation Rating: Class 130 (A)
- **Coil Offering** — encapsulated:
  - NEMA Sizes 4 – 5
  - UL Insulation Rating: Class 155 (F)
- **Operational Limits:**
  - 85% to 110% of rated voltage — ac
  - 80% to 110% of rated voltage — dc

Table 31.3-2. Coil Data Notes

Description	
P.U.	Pickup time is the average time taken from closing of the coil circuit to main contact touch.
D.O.	Dropout time is the average time taken from opening of the coil circuit to main contact separation.
Cold	Coil data with a cold coil.
Hot	Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 Vac or 24 Vdc magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

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Table 31.3-3. dc Coil Data

NEMA Sizes	Motor Voltage	P.U.			Sealed		D.O. Volts (Hot)	P.U. Time ms	D.O. Time ms	Maximum Operation Rate Operations/Hour	Mechanical Life Millions
		Amperes	Watts	Volts (Hot)	Amperes	Watts					
00 and 0	12	6.4	76.8	80%	0.28	3.36	60%	22	17	3,600	5
	24	3.2	76.8	80%	0.14	3.36	60%	22	17	3,600	5
	48	1.6	76.8	80%	0.07	3.36	60%	22	17	3,600	5
	120	0.64	76.8	80%	0.028	3.36	60%	22	17	3,600	5
1 and 2	12	15.4	126	68%	0.42	4.98	30%	21	12	3,600	2
	24	6.2	88.4	60%	0.21	4.96	29%	20	13	3,600	2
	48	2.9	76.2	56%	0.11	5.04	28%	20	14	3,600	2
	120	1.1	67.3	53%	0.041	4.87	29%	20	16	3,600	2
3	12	24	293	65%	0.40	4.84	23%	39	14	3,600	2
	24	12	288	61%	0.20	4.75	22%	38	14	3,600	2
	48	6.1	295	62%	0.097	4.67	22%	37	14	3,600	2
	120	2.5	298	61%	0.038	4.57	22%	37	16	3,600	2
4 and 5	24	18	400	67%	0.22	5.3	25%	53	14	2,400	2
	48	9.0	400	67%	0.11	5.2	25%	49	16	2,400	2
	120	3.3	450	65%	0.05	5.4	28%	56	19	2,400	2
	240	1.7	440	64%	0.02	4.9	26%	49	21	2,400	2
6	106	8.3	775	N/A	0.085	9	N/A	N/A	N/A	2,400	5
	214	4.1	775	N/A	0.042	9	N/A	N/A	N/A	2,400	5
	340	2.6	775	N/A	0.026	9	N/A	N/A	N/A	2,400	5
	430	2.0	775	N/A	0.021	9	N/A	N/A	N/A	2,400	5
7	106	13.9	1425	N/A	0.184	19.5	N/A	N/A	N/A	1,200	5 ①
	214	6.9	1425	N/A	0.091	19.5	N/A	N/A	N/A	1,200	5 ①
	340	4.3	1425	N/A	0.057	19.5	N/A	N/A	N/A	1,200	5 ①
	430	3.4	1425	N/A	0.045	19.5	N/A	N/A	N/A	1,200	5 ①
8	106	19.8	2100	N/A	0.566	60	N/A	N/A	N/A	600	5 ①
	214	9.8	2100	N/A	0.280	60	N/A	N/A	N/A	600	5 ①
	340	6.2	2100	N/A	0.176	60	N/A	N/A	N/A	600	5 ①
	430	4.9	2100	N/A	0.139	60	N/A	N/A	N/A	600	5 ①

① Change amature, magnet and amature interlock after 1 x 10 operations.

General Coil Data

- **Coil Offering** — tape wound:
  - NEMA Sizes 00 – 0
  - UL Insulation Rating: Class 130 (B)
- **Coil Offering** — encapsulated:
  - NEMA Sizes 1 – 3
  - UL Insulation Rating: Class 130 (A)
- **Coil Offering** — encapsulated:
  - NEMA Sizes 4 – 5
  - UL Insulation Rating: Class 155 (F)
- **Operational Limits:**
  - 85% to 110% of rated voltage — ac
  - 80% to 110% of rated voltage — dc

Table 31.3-4. Coil Data Notes

Description	
P.U.	Pickup time is the average time taken from closing of the coil circuit to main contact touch.
D.O.	Dropout time is the average time taken from opening of the coil circuit to main contact separation.
Cold	Coil data with a cold coil.
Hot	Coil data with a hot coil.

All data is based on a standard contactor with no auxiliary devices and a 120 Vac or 24 Vdc magnet coil. Coil data has a ±5% range depending on the application, therefore specific data may vary.

Table 31.3-5. Specifications — Sizes 00 – 3

Description	Contactor Catalog Number/Size				
	CN15A NEMA Size 00	**CN15B NEMA Size 0**	**CN15D NEMA Size 1**	**CN15G NEMA Size 2**	**CN15K NEMA Size 3**
Configuration Number of Poles Auxiliary Contacts, Standard Add-on Auxiliary Contacts	 2, 3, 4 4th Pole NO (1) Top (4) or Side (4)	 2, 3 Side NO (1) Top (4) or Side (3)	 2, 3, 4, 5 Side NO (1) Top (4) or Side (3)	 2, 3, 4, 5 Side NO (1) Top (4) or Side (3)	 2, 3 Side NO (1) Left Side (4) or Right Side (3)
Frame Size	45 mm	45 mm	65 mm	65 mm	90 mm
Maximum Voltage Rating	600 Vac	600 Vac	600 Vac	600 Vac	600 Vac
Continuous Ampere Ratings (I)	9 Amperes	18 Amperes	27 Amperes	45 Amperes	90 Amperes
Maximum Horsepower (hp) 1-Phase 115 V 230 V	 1/3 1	 1 2	 2 3	 3 7-1/2	 7-1/2 15
3-Phase 200 V 230 V 460 V 575 V	1-1/2 1-1/2 2 2	3 3 5 5	7-1/2 7-1/2 10 10	10 15 25 25	25 30 50 50
Coil Operating Range % of Rated Voltage	-15% to +10%	-15% to +10%	-15% to +10%	-15% to +10%	-15% to +10%
Operating Temperature Maximum Operating Altitude in Feet (m) Mechanical Life	-20° to 65°C 6,000 (1828) 20,000,000	-20° to 65°C 6,000 (1828) 20,000,000	-20° to 65°C 6,000 (1828) 10,000,000	-20° to 65°C 6,000 (1828) 10,000,000	-20° to 65°C 6,000 (1828) 6,000,000
Electrical Life (480 V/60 Hz) AC-3 AC-4	 4,000,000 90,000	 3,000,000 85,000	 5,000,000 200,000	 3,500,000 62,000	 1,700,000 80,000
Wire Range Power Terminals Control Terminals	 12 – 16 Stranded, 12 – 14 Solid Cu 12 – 16 Stranded, 12 – 14 Solid Cu	 8 – 16 Stranded, 10 – 14 Solid Cu 12 – 16 Stranded, 12 – 14 Solid Cu	 8 – 14 Stranded or Solid Cu 12 – 16 Stranded, 12 – 14 Solid Cu	 2 – 14 (Upper) and/ or 6 – 14 (Lower) Stranded or Solid Cu 12 – 16 Stranded, 12 – 14 Solid Cu	 1/0 – 14 Cu 12 – 16 Stranded 12 – 14 Solid Cu
Power Terminal Torque Line and Load — lb-in	7	15	20	40 (14 – 8 AWG) 45 (6 – 4 AWG) 50 (3 AWG)	35 (14 – 10 AWG) 40 (8 AWG) 45 (6 – 4 AWG) 50 (3 – 1/0 AWG)
Auxiliary Contact Rating	A600, P300				

Table 31.3-6. Specifications — Sizes 4 – 8

Description	Contactor Catalog Number/Size				
	CN15N NEMA Size 4	**CN15S NEMA Size 5**	**CN15T NEMA Size 6**	**CN15U NEMA Size 7**	**CN15V NEMA Size 8**
Configuration					
Number of Poles	2, 3	2, 3	3	3	3
Auxiliary Contacts, Standard	Side NO (1)	Side NO (1)	Top Left 2NO/2NC (1)	Top Left 2NO/2NC (1)	Side 2NO/NC (1)
Add-on Auxiliary Contacts	Left Side (3) or Right Side (4)	Left Side (3) or Right Side (4)	Top Right 2NO/2NC (1)	Top Right 2NO/2NC (1)	NO/NC (2)
Frame Size	180 mm	180 mm	280 mm	280 mm	334 mm
Maximum Voltage Rating	600 Vac	600 Vac	600 Vac	600 Vac	600 Vac
Continuous Ampere Ratings (I)	135 Amperes	270 Amperes	540 Amperes	810 Amperes	1215 Amperes
Maximum Horsepower (hp)					
1-Phase 115 V	—	—	—	—	—
230 V	—	—	—	—	—
3-Phase 200 V	40	75	150	200	400
230 V	50	100	200	300	450
460 V	100	200	400	600	900
575 V	100	200	400	600	900
Coil Operating Range % of Rated Voltage	-15% to +10%	-15% to +10%	-15% to +10%	-15% to +10%	-15% to +10%
Operating Temperature	-20° to 65°C	-20° to 65°C	-20° to 65°C	-20° to 65°C	-20° to 65°C
Maximum Operating Altitude in Feet (m)	6,000 (1828)	6,000 (1828)	6,000 (1828)	6,000 (1828)	6,000 (1828)
Mechanical Life	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Electrical Life (480 V/60 Hz)					
AC-3	800,000	500,000	590,000	450,000	420,000
AC-4	70,000	34,000	7,400	5,000	4,200
Wire Range	Open — 3/0 – 8 Cu;	750 kcmil — 2 or	(2) 750 kcmil –	(3) 750 kcmil –	(4) 750 kcmil –
Power Terminals	Enclosed — 250 kcmil – 6 Cu/Al	(2) 250 kcmil – 3/0 Cu/Al	3/0 Cu/Al	3/0 Cu/Al	1/0 Cu/Al
Control Terminals	12 – 16 Stranded, 12 – 14 Solid Cu	12 – 16 Stranded, 12 – 14 Solid Cu	12 – 16 Stranded, 12 – 14 Solid Cu	12 – 16 Stranded, 12 – 14 Solid Cu	12 – 16 Stranded, 12 – 14 Solid Cu
Power Terminal Torque Line and Load — lb-in	200	550	550	550	500
Auxiliary Contact Rating	A600, P300				

Table 31.3-7. 380 Volts, 50 Hz Starters — Maximum hp Ratings

Description	NEMA Size					
	1	2	3	4	5	6
Maximum hp	10	25	50	75	150	300

Table 31.3-8. Motor FLA Current Ranges

Description	NEMA Size						
	1 ①	1	2	3	4	5	6
1.15 to 1.25 S.F.	0.47 – 3.81	3.15 – 27.00	3.15 – 45.00	9.90 – 90.00	9.90 – 135.00	38.30 – 270.00	38.30 – 540.00
1.0 S.F.	0.51 – 4.14	3.43 – 27.00	3.43 – 45.00	10.80 – 90.00	10.80 – 135.00	41.70 – 270.00	41.70 – 540.00

① Size 1 Lower Current Range for motor hp range 1/4 hp to 2 hp at 460 V.

Table 31.3-9. Maximum Horsepower Rating of Starters for 380 V, 50 Hz Application

IEC Size	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S
hp	3	5	5	10	10	15	20	25	30	40	50	60	75	100	125	150

Table 31.3-10. Wire (75°C) Sizes — AWG or kcmil — NEMA Sizes 00 – 2 — Open and Enclosed

NEMA Size	Cu Only
Power Terminals — Line	
00	#12 – #16 Stranded, #12 – #14 Solid
0	#8 – #16 Stranded, #10 – #14 Solid
1	#8 – #14 Stranded or Solid
2	#3 – #14 (Upper) and/or #6 – #14 (Lower) Stranded or Solid ②

② Two compartment box lug.

Table 31.3-11. Overload Relay UL/CSA Contact Ratings Control Circuit ③

ac Volts	120 V	240 V	480 V	600 V
NC Contact B600				
Make and Break Amperes	30	15	7.5	6
Break Amperes	3	1.5	.75	.6
Continuous Amperes	5	5	5	5
NO Contact C600				
Make and Break Amperes	15	7.5	3.375	3
Break Amperes	1.5	.75	.375	.3
Continuous Amperes	2.5	2.5	2.5	2.5

③ dc ratings cover Freedom Series coils only.

Table 31.3-12. Wire (75°C) Sizes — AWG or kcmil — NEMA Sizes 00 – 2 Open and Enclosed

Catalog Number	Terminal	Wire Size
Power Terminals — Load — Cu Only (Stranded or Solid)		
C306DN38	32A	14 – 6 AWG
C306GN38	75A	14 – 2 AWG

④ Minimum per NEC. Maximum wire size: Sizes 00 – 0 to 8 AWG and Sizes 1 – 2 to 2 AWG.

Table 31.3-13. Wire (75°C) Sizes — AWG or kcmil — NEMA Sizes 3 – 8 — Open and Enclosed

NEMA Size	Wire Size
Power Terminals — Line and Load	
3	#1/0 – #14 Al Cu
4	Open – #3/0 – #8 Cu Enclosed – 250 kcmil – #6 Al Cu
5	750 kcmil – #2 or (2) 250 kcmil – #3/0 Al Cu
6	(2) 750 kcmil – #3/0 Al Cu
7	(3) 750 kcmil – #3/0 Al Cu
8	(4) 750 kcmil – #1/0 Al Cu

Table 31.3-14. Control Terminals — Cu Only

(2) #12 – #16 Stranded
(2) #12 – #14 Solid

Electrical Life — AC-3 and AC-4 Utilization Categories

Life Load Curves

Eaton's Cutler-Hammer Freedom Series NEMA contactors have been designed and manufactured for superior life performance in any worldwide application. All testing has been based on requirements as found in NEMA and UL standards and conducted by Eaton. Actual application life may vary depending on environmental conditions and application duty cycle.

Utilization Categories

AC-1 — Non-inductive or slightly inductive loads, such as resistance furnaces and heating.

AC-2 — Starting of slip-ring motors.

AC-3 — Squirrel cage motors; starting, switching off motors during running.

AC-4 — Squirrel cage motors; starting, plugging, inching or jogging.

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Note: AC-3 tests are conducted at rated device currents and AC-4 tests are conducted at six times rated device currents. All tests have been run at 460 V, 60 Hz.

Contactor Choice

- Decide what utilization category your application is and choose the appropriate curve.
- Locate the intersection of the life-load curve of the appropriate contactor with the applications operational current (Ie), as found on the horizontal axis.
- Read the estimated contact life along the vertical axis in number of operational cycles.

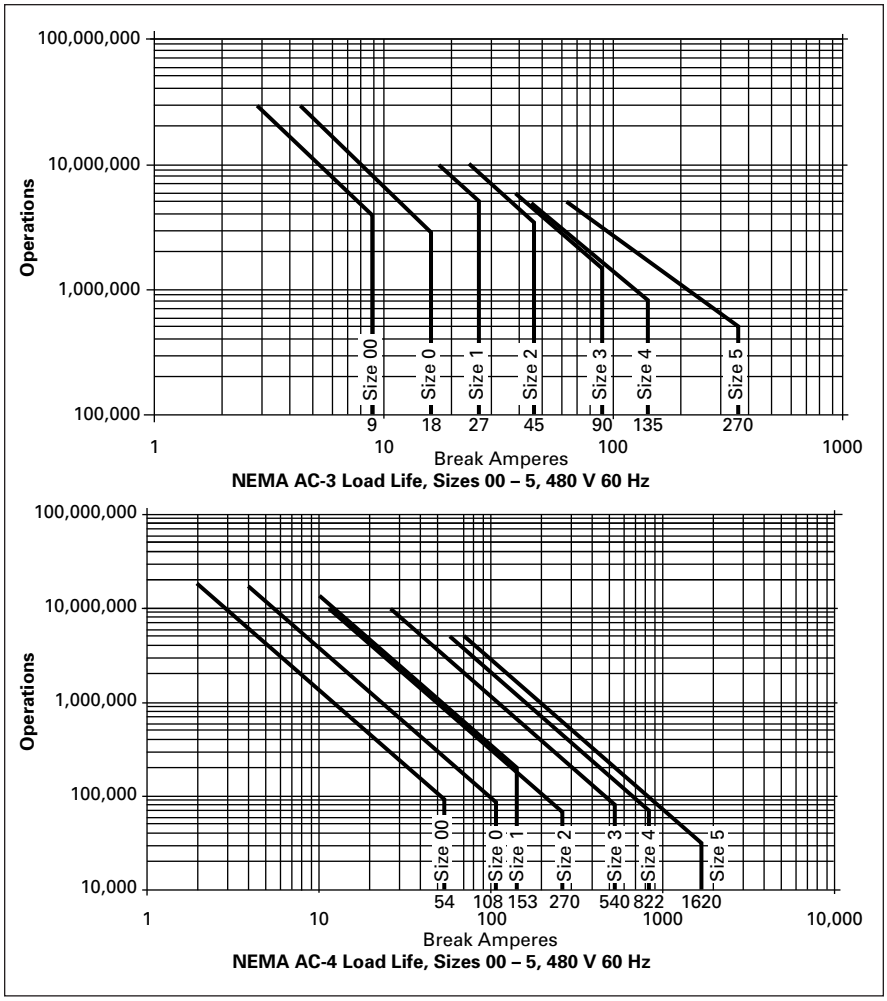

Figure 31.3-2. AC-3 and AC-4 Utilization Categories

Catalog Number Selection

Table 31.3-15. NEMA Freedom Line Enclosed Control Catalog Numbering System

ECN 22 2 1 A A F - __

Design
N = Freedom NEMA

Class
01 = Contactors
02 = Reversing Contactors
05 = FVNR Starter, Non-combination
06 = Reversing, Non-combination
07 = FVNR Non-combination, with CPT
08 = Single-Phase FVNR (Freedom Only)
16 = Combination with Disconnect Switch
17 = Reversing, Combination with Disconnect Switch
18 = Combination with Disconnect Switch, with CPT
22 = Combination with HMCP/E
23 = Reversing, Combination with HMCP/E
24 = Combination with HMCP/E with CPT
33 = Multispeed 2S2W Non-combination
34 = Multispeed 2S1W CT or VT Non-combination
35 = Multispeed 2S1W CH Non-combination
36 = Multispeed with Disconnect Switch, 2S2W
37 = Multispeed with Disconnect Switch, 2S1W CT or VT
38 = Multispeed with Disconnect Switch, 2S1W CH
39 = Multispeed with HMCP/E, 2S2W
40 = Multispeed with HMCP/E, 2S1W CT or VT
41 = Multispeed with HMCP/E, 2S1W CH

NEMA Size
A = Size 00
0 = Size 0
1 = Size 1
2 = Size 2
3 = Size 3
4 = Size 4
5 = Size 5
6 = Size 6
7 = Size 7
8 = Size 8
9 = Size 9

Enclosure Type
1 = Type 1 — General Purpose
2 = Type 3R — Rainproof
3 = Type 4 — Watertight (Painted Steel)
4 = Type 4X — Watertight (304-Grade Stainless Steel)
5 = Type 4X — Corrosion (Nonmetallic)
6 = Type 7/9 — Bolted Hazardous Location
7 = Type 7/9 — Threaded Hazardous Location
8 = Type 12 — Dust-Tight
9 = Type 4X — 316-Grade Stainless Steel

Cover Control
(Starters Only)
(Contact Eaton)
Number of Poles
(Contactors Only)

Coil Voltage and/or Control Transformers
(See Tables Below)

Modification Codes
(See PG03300001E)

Disconnect Fuse Clip Ratings

A = None	**H** = 200 A/250 V R	**Q** = 1200 A/600 V L
B = 30 A/250 V R	**J** = 200 A/600 V R	**R** = 1600 A/600 V L
C = 30 A/600 V R	**K** = 400 A/250 V R	**S** = 2000 A/600 V L
D = 60 A/250 V R	**L** = 400 A/600 V R	**T** = by Description
E = 60 A/600 V R	**M** = 600 A/250 V R	**U** = Engineered
F = 100 A/250 V R	**N** = 600 A/600 V R	
G = 100 A/600 V R	**P** = 800 A/600 V L	

HMCP/E or Breaker Ratings

A = None	**J** = 250 A	**U** = Engineered
B = 3 A	**K** = 400 A	**5** = 3 A ①
C = 7 A	**L** = 600 A	**6** = 7 A ①
D = 15 A	**M** = 800 A	**7** = 15 A ①
E = 30 A	**N** = 1000 A	**8** = 30 A ①
F = 50 A	**P** = 1200 A	**9** = 50 A ①
W = 70 A	**Q** = 2000 A	**I** = 100 A ①
G = 100 A	**R** = 3000 A	
H = 150 A	**T** = by Description	

① Use for Sizes 0 – 3, HMCP 600 V applications only.

Table 31.3-16. Magnetic Coil Codes (System Voltage) ②

Code	Magnet Coil	Code	Magnet Coil	Code	Magnet Coil
A	120/60 110/50	**K**	240/50	**U**	24/50
B	240/60 220/50	**L**	380/50	**V**	32/50
C	460/60 440/50	**M**	415/50	**W**	48/60
D	575/60 550/50	**P**	12 Vdc	**X**	104 – 120/60
E	208/60	**Q**	24 Vdc	**Y**	48/50
G	550/50	**R**	48 Vdc	**Z**	By Description
H	277/60	**S**	125 Vdc		
J	208 – 240/60	**T**	24/60		

② When control power transformer modification codes (**C1** – **C11**) are used or when starter class includes CPT (i.e., ECN07, 18) see table to the right for system voltage code.

Table 31.3-17. Control Power Transformer Codes (System Voltage)

Code	Primary	Secondary
B	240/480 – 220/440 Wired for 240 V	120/60 – 110/50
C	240/480 – 220/440 Wired for 480 V	120/60 – 110/50
D	600/60 – 550/50	120/60 – 110/50
E	208/60	120/60
H	277/60	120/60
L	380/50	110/50
M	415/50	110/50
Q	208/60	24
R	240/480 – 220/440 Wired for 240 V	24
S	240/480 – 220/440 Wired for 480 V	24
T	600/60	24
U	277/60	24
V	380/50	24
W	415/50	24
X	240/480/600 Wired for 480 V	120
Y	240/480/600 Wired for 480 V	24
Z	By Description	

Enclosed Box Selection

Table 31.3-18. Type 1 Freedom Contactors

NEMA Size (Poles)	Box No.	Shipping Weight Lbs. (kg)
Non-reversing Contactors — without Control Power Transformers		
00 (2P, 3P, 4P)	1	5.25 (2.4)
00 (2P, 3P, 4P) with top adders	2	7.3 (3.3)
0 (2P, 3P, 4P)	1	5.25 (2.4)
0 (2P, 3P, 4P) with top adders	2	7.3 (3.3)
0 (5P)	2	7.3 (3.3)
1 (2P, 3P)	1	7.9 (3.6)
1 (2P, 3P) with top adders	3	11 (5.0)
1 (4P, 5P)	2	8.3 (3.8)
2 (2P, 3P, 4P 5P)	2	8.5 (3.9)
3 (2P, 3P)	4	35 (16)
4 (2P, 3P)	4	47 (21)
5	10	113 (51)
6	F1E	325 (148)
7	F1E	①
8	F1E	①
9	F1E	①
Non-reversing Contactors — with Control Power Transformers		
00 (2P, 3P, 4P)	2	12 (5.4)
00 (2P, 3P, 4P, 5P) with top adders	3	15 (6.8)
0 (2P, 3P, 4P, 5P)	2	12 (5.4)
0 (2P, 3P, 4P, 5P) with top adders	3	15 (6.8)
1 (2P, 3P)	2	12.2 (5.5)
1 (2P, 3P) with top adders	3	12.5 (5.7)
1 (4P, 5P)	2	12.6 (5.7)
2 (2P, 3P, 4P, 5P)	2	12.8 (5.8)
3 (2P, 3P)	4	40 (18)
4 (2P, 3P)	4	52 (24)
5	10	120 (54)
6	F1E	335 (152)
7	F1E	①
8	F1E	①
9	F1E	①
3-Pole Reversing Contactors — without Control Power Transformers		
00	2	7.8 (3.5)
0	2	8 (3.6)
1	3	11 (5.0)
2	3	12 (5.4)
3	4	67 (30)
4	4	154 (70)
5	10	170 (77)
6	F1E	425 (193)
7	F1E	①
8	F1E	①
9	F2E	①

① Consult factory.

Table 31.3-19. Type 3R, 4/4X, 12 Freedom Contactors

NEMA Size (Poles)	Box No.	Shipping Weight Lbs. (kg)
Non-reversing Contactors — without Control Power Transformers		
00	5	14 (6.4)
0 (2P, 3P, 4P)	5	14 (6.4)
1 (2P, 3P, 4P, 5P)	5	15 (6.8)
2 (2P, 3P, 4P, 5P)	5	15.5 (7.0)
3 (2P, 3P)	8	45 (20)
4 (2P, 3P)	8	56 (25)
5	10	140 (64)
6	F1E	385 (175)
7	F1E	②
8	F1E	②
9	F1E	②
Non-reversing Contactors — with Control Power Transformers		
00	5	18 (8.2)
0 (2P, 3P, 4P)	5	18 (8.2)
1 (2P, 3P, 4P, 5P)	6	19 (8.6)
2 (2P, 3P, 4P, 5P)	6	19.5 (8.9)
3 (2P, 3P)	8	52 (24)
4 (2P, 3P)	8	63 (29)
5	10	147 (67)
6	F1E	405 (184)
7	F1E	②
8	F1E	②
9	F1E	②
3-Pole Reversing Contactors — with or without Control Power Transformers		
00	6	18 (8.2)
0	6	18 (8.2)
1	6	19 (8.6)
2	6	19 (8.6)
3	8	47 (21)
4	9	69 (31)
5	10	170 (77)
6	F1E	495 (225)
7	F1E	②
8	F1E	②
9	F2E	②

② Consult factory.

Table 31.3-20. Type 1 Freedom Non-combination Starters

NEMA Size	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Starters — without Control Power Transformers		
00	1	7 (3.2)
00 with top adders/SSOL	2	10 (4.5)
0	1	7.1 (3.2)
0 with top adders/SSOL	2	10 (4.5)
1	1	7.9 (3.6)
1 – 2 with top adders/SSOL	3	11.5 (5.2)
2	2	8.5 (3.9)
3	4	35 (16)
4	4	47 (21)
5	10	139 (63)
6	F1E	360 (163)
7	F1E	③
8	F1E	③
9	F1E	③
Non-reversing Starters — with Control Power Transformers		
00	3	15 (6.8)
0	3	15 (6.8)
1	3	16 (7.3)
2	3	16.2 (7.4)
3	4	42 (19)
4	4	54 (25)
5	10	146 (66)
6	F1E	385 (175)
7	F1E	③
8	F1E	③
9	F1E	③
Reversing Starters — without Control Power Transformers		
00	2	8 (3.6)
0	2	8 (3.6)
0 with top adders	3	11 (5)
1	3	13 (5.9)
1 with top adders	3	13.4 (6.1)
2	3	15 (6.8)
3	4	43 (20)
4	9	65 (30)
5	10	165 (75)
6	F1E	450 (204)
7	F1E	③
8	F2E	③
9	F2E	③
Reversing Starters — with Control Power Transformers		
00 with top adders	3	15 (6.8)
0	3	15 (6.8)
1 with top adders	3	17 (7.7)
2	3	19 (8.6)
3	4	50 (23)
4	9	72 (33)
5	10	172 (78)
6	F1E	495 (225)
7	F1E	③
8	F2E	③
9	F2E	③

③ Consult factory.

Table 31.3-21. Type 3R, 4/4X, 12 Freedom Non-combination Starters

NEMA Size / IEC Frame	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Starters — without Control Power Transformers		
0	5	14.3 (6.5)
1	5	15.3 (6.9)
2	7	16 (7.3)
3	8	46 (21)
4	8	60 (27)
5	10	150 (68)
6	F1E	415 (188)
7	F1E	①
8	F1E	①
9	F1E	①
Non-reversing Starters — with Control Power Transformers		
0	6	18 (8.2)
1	6	19 (8.6)
2	6	20 (9)
3	8	53 (24)
4	8	67 (30)
5	10	157 (71)
6	F1E	①
7	F1E	①
8	F1E	①
9	F1E	①
Reversing Starters — with or without Control Power Transformers		
0	7	18.5 (8.4)
1	7	19.5 (8.9)
2	7	21 (10)
3	8	48 (22)
4	9	72 (33)
5	10	175 (79)
6	F1E	525 (238)
7	F1E	①
8	F2E	①
9	F2E	①

① Consult factory.

Table 31.3-22. Type 1 Freedom Combination Starters

NEMA Size (Device)	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing — with and without Control Power Transformers		
0	A	37 (17)
1	A	38 (17)
2	A	39 (18)
3	C	72 (33)
4 (HMCP)	C	90 (41)
4 (Disconnect Switch)	D	150 (68)
5	E	180 (82)
6	F1E	435 (197)
7	F2E	②
8	F2E	②
9	F2E	②
Reversing — with and without Control Power Transformers		
0	B	42 (19)
1	B	43 (20)
2	B	44 (20)
3	C	84 (38)
4	D	173 (79)
5	F1E	②
6	F1E	550 (250)
7	F2E	②
8	F2E	②
9	②	②
Non-reversing — Oversized		
0 – 1 – 2	B	44 (20)

② Consult factory.

Table 31.3-23. Type 1 Freedom Non-reversing Combination Starters — Narrow Enclosure

NEMA Size	Box No.	Shipping Wt. Lbs. (kg)
NEMA 1 Enclosed		
0 – 1 – 2	I	35 (16)
NEMA 12 Enclosed		
0 – 1 – 2	I	36 (16)
NEMA 12 Enclosed with Safety Door Interlock		
0 – 1 – 2	I	37 (17)

Table 31.3-24. Type 3R, 4/4X, 12 Freedom Combination Starters

NEMA Size (Device)	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing — with and without Control Power Transformers		
0	A	37 (17)
1	A	38 (17)
2	A	39 (18)
3	C	72 (33)
4 (HMCP)	C	90 (41)
4 (Disconnect Switch)	D	150 (68)
5	E	180 (82)
6	F1E	435 (197)
7	F2E	③
8	F2E	③
9	F2E	③
Reversing — with and without Control Power Transformers		
0	B	42 (19)
1	B	43 (20)
2	B	44 (20)
3	C	84 (38)
4	D	173 (79)
5	E	550 (250)
6	F1E	③
7	F2E	③
8	F2E	③
9	③	③
Non-reversing — Oversized		
0 – 1 – 2	B	44 (20)

③ Consult factory.

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For enclosure box dimensions, refer to Page 31.7-3.

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IT. Contactors and Starters

IT. B-Frame Contactor

IT. D-Frame Starter

Description

Eaton's Cutler-Hammer Intelligent Technologies (***IT.***) electromechanical products include greatly increased functionality, significantly reduced size, and utilize 24 Vdc control. The exclusive Pulse Width Modulation (PWM) controller generates the optimum dc level required for coil control, reducing energy requirements while resulting in the most compact system available. These products are available in several configurations including non-reversing and reversing contactors and starters.

An ***IT.*** IEC or NEMA Electromechanical Contactor consists of an ***IT.*** Contact Block and a Coil Controller, which may be field assembled. The use of microprocessor-based control for the ***IT.*** Starter eliminates the need for a seal-in auxiliary contact and provides overload, phase loss and phase current unbalance protection and an alarm output.

Cutler-Hammer ***IT.*** Electromechanical Contactors and Starters include the following significant features:

- 24 Vdc control power, a safe reliable global standard.
- Up to 40% smaller than typical electromagnetic equivalents.
- Unique Pulse Width Modulated coil provides high efficiency and low energy consumption.
- Wide operating temperature range of -40°C to 65°C (-40°F to 149°F).
- DIN rail or panel mounting for 6 to 100 ampere products.
- Highly accessible mounting feet for easy panel mounting.
- Mounting plates with "ease of installation" slotted holes for 18 to 200 ampere products.
- Front mounted auxiliary contacts.
- Long-life silver nickel and silver tin contacts provide excellent conductivity and superior resistance to welding and arc erosion.
- IP20 finger protection.
- No laminations, shading coils, or magnet noise.
- Unique reversing control energizes both the forward and reverse contactors with only one wiring point.
- Easy field assembly of control wiring.
- No user wiring between the Overload or Coil Controller and the Contact Block.
- Common product line accessories.

IT. Starters include these additional features:

- Microprocessor-based control.
- User-selectable phase loss and current unbalance protection.
- Selectable Trip Class — 10, 20 or 30.
- Ambient compensation.
- Protection algorithm which simulates motor temperature.
- Thermal memory at power up.
- Running motor thermal capacity utilization indication.
- Alarm output.
- Unique "Alarm without Trip" function for critical must run applications.
- Lockable cover protects adjustment and reset functions.
- LED indication for trip, overload status, motor thermal state, availability of reset, and Trip Class setting.
- Selectable Manual, Remote or Auto Reset.
- Communication Interface.

Overload Default Setting

- NEMA trip class: 20.
- Ambient compensated (-40°C to +65°C).
- 50/60 Hz, 3-phase starters only.
- Phase loss and unbalance protection "ON".
- Motor service factor: ≥ 1.15.
- FLA dial set to minimum.

Overload FLA Setting

The overload FLA setting customizes the ***IT.*** Overload Relay for the motor being used. The ***IT.*** Overload Relay is calibrated for a 1.15 or higher service factor motor, with an ultimate trip at 1.2 times the FLA setting as illustrated in **Figure 31.4-1**. This is consistent with the operation of other types of overload devices for 1.15 service factor motors.

Note: The overload Trip Class must be set before adjusting the overload FLA setting if the Trip Class is to be different than the factory default settings.

To access the FLA/CLASS dial, the hinged cover over the dial must be opened. The cover and the FLA/CLASS dial are illustrated in **Figure 31.4-2**.

Overload Class Setting

The ***IT.*** Overload can be set to provide Class 10, 20 or 30 overload protection, with or without phase loss/unbalance protection.

Power Source

Eaton's Cutler-Hammer ***IT.*** Electromechanical Contactors and Starters are designed for use with 3-phase line voltages of 200, 208, 230, 240, 380, 415, 460, 480 and 575 at a line frequency of 50 or 60 Hz.

The ***IT.*** Contactor may be used in single-phase applications at 120 and 220 volts, but the ***IT.*** Starter is limited to 3-phase applications.

IT. Contactors and Starters must be installed with upstream protection as required by national and local installation codes and rules.

Power Wiring — Introduction

The three ac line power connections are made to the ***IT.*** Contactor or Starter inputs marked 1, 3 and 5 and L1, L2 and L3. The three motor power connections are made directly to the ***IT.*** Contactor outputs or to the ***IT.*** Overload Relay outputs for the ***IT.*** Starter to the terminals marked 2, 4 and 6 and T1, T2 and T3. Use Class B, 75ºC copper wire only (or 90ºC copper wire oversized for 75ºC operation) in accordance with the National Electrical Code (NEC) and other local regulations as applicable.

Note: The control terminal block must be removed before wiring the T1, T2 and T3 leads of the B, C and D Starter Frames.

Control Wiring — General

All of the control connections, including the contactor coil, are made to the ***IT.*** Coil Controller or Overload Relay terminal block. For the ***IT.*** Contactor Frames A (27 mm) to C (54 mm), a four-point terminal block is used for all non-reversing applications. For reversing contactors an eight-point terminal block is used but the terminals marked 1, 2 and 3 are unused, except for the A-Frame which uses a single five-point terminal block and the F-Frame which uses multiple five-point terminal blocks.

For the ***IT.*** B- through F-Frame Starters, an eight-point terminal block is supplied for reversing and non-reversing applications. The difference is the use of the "R" terminal for the reversing starter. For a non-reversing application, this terminal is marked but unused. The F-Frame Starter also uses a five-point terminal block. Control wiring requirements for AC-4 applications are the same as for AC-3 applications.

Control wire size ranges, lug torques and tool types are shown in **Table 31.4-9**.

Note: The wire used for the ± 24 Vdc power supply connections to the ***IT.*** Coil Controller and Overload Relay terminal blocks should take into account voltage drop due to coil inrush requirements. Refer to the application note on 24 Vdc Voltage Drop, available online at: **www.EatonElectrical.com**.

Pilot devices must be rated for use with a 24 Vdc low current (3 mA dc) dry circuit to ensure reliable operation. See **Table 31.4-8** for recommendations.

The ON/OFF control, an E-stop maintained contact, is optional for installations requiring the removal of power from the control circuitry to open the contactor independently of the normal ON/OFF circuit. Caution must be exercised to ensure that the E-stop contact is not closed when the ON/OFF control pilot device is already closed to prevent an unintended restart.

Wiring Cautions

For reversing applications, the "Forward" input will always override a "Reverse" input, if both are closed.

Caution must be exercised to prevent an unintended direction change.

When using the Auto Reset, Remote Reset or E-stop features, caution must be exercised to prevent an unintended restart from causing personal injury or equipment damage.

Control Wiring — Contactors and Starters

A remote Trip Reset contact (see **Table 31.4-8**) may be used, if desired, to reset the ***IT.*** Starter after a trip. Caution must be exercised to ensure that the ON/OFF control pilot device is not closed to prevent an unintended restart. If the Auto Reset feature is used, caution must be exercised to ensure that any restart occurs in a safe manner. A solid-state alarm output is available.

Figures 31.4-13 and **31.4-14** illustrate the terminal connections for the eight-point terminal connections for the B-, C-, D-, and E-Frames. A remote Trip Reset contact (see **Table 31.4-8**) may be used, if desired, to reset the ***IT.*** Starter after a trip. Caution must be exercised to ensure that the Start contact is not closed to prevent an unintended restart. Refer to the Protective Trip and Trip Reset sections for further information on the Remote Reset feature. If the Auto Reset feature is used, caution must be exercised to assure that any restart occurs in a safe manner. A solid-state alarm output is available, see the Alarm Output section for information.

24 Vdc Power Supply Selection

The ***IT.*** Coil Controller, Overload Relay and Contact Block coil require 24 Vdc control power.

Note: The wire used for the ± 24 Vdc power supply connections to the ***IT.*** Coil Controller and Overload Relay terminal blocks should take into account voltage drop due to coil inrush. Use of any other voltage may result in personal injury, property damage, and will damage the ***IT.*** device.

Control voltage must be in the range of 20 – 28 Vdc under all conditions. The Cutler-Hammer control power supplies listed in **Table 31.4-1** are recommended.

Caution: *Only apply 24 Vdc to any of the terminals of the* ***IT.*** *Coil Controller or* ***IT.*** *Overload control terminal block.*

Use of Multiple Contactors or Starters on One Power Supply

In order to determine the proper power supply for use with multiple contactors or starters, the number of devices closing simultaneously, and those already closed, must be predetermined. A calculation may then be made to ensure the appropriateness of the power supply selected.

Table 31.4-1. *IT.* Control Standard Power Supply Recommendations

24 Vdc Power Supply					Catalog Number
Continuous		Peak		Input Voltage	
Wattage	Amperes	Wattage	Amperes		
10	0.4	20	0.8	90 – 264 Vac	**PSS10E**
25	1.0	165	6.5	90 – 264 Vac	**PSS25E**
10	0.4	20	0.8	380 – 480 Vac	**PSS10F**
25	1.0	165	6.5	380 – 480 Vac	**PSS25F**
55	2.3	250	10.0	115 Vac	**PSS55A**
55	2.3	250	10.0	230 Vac	**PSS55B**
55	2.3	250	10.0	360 – 480 Vac	**PSS55C**
—	—	—	—	90 – 260 Vac	**PSS160E**
—	—	—	—	360 – 500 Vac	**PSS160C**
—	—	—	—	90 – 260 Vac	**PSS300E**
—	—	—	—	360 – 500 Vac	**PSS300C**
—	—	—	—	360 – 500 Vac	**PSS600C**

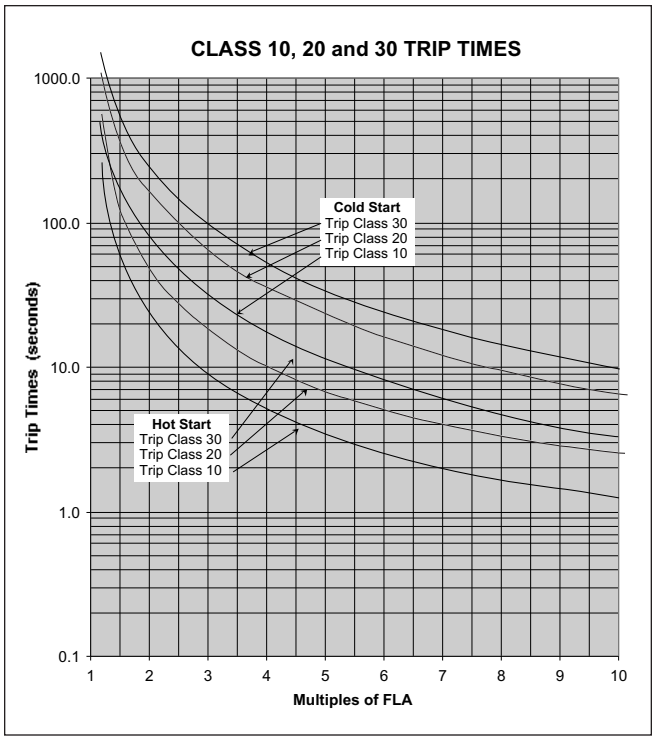

Figure 31.4-1. *IT.* Overload Trip Curves

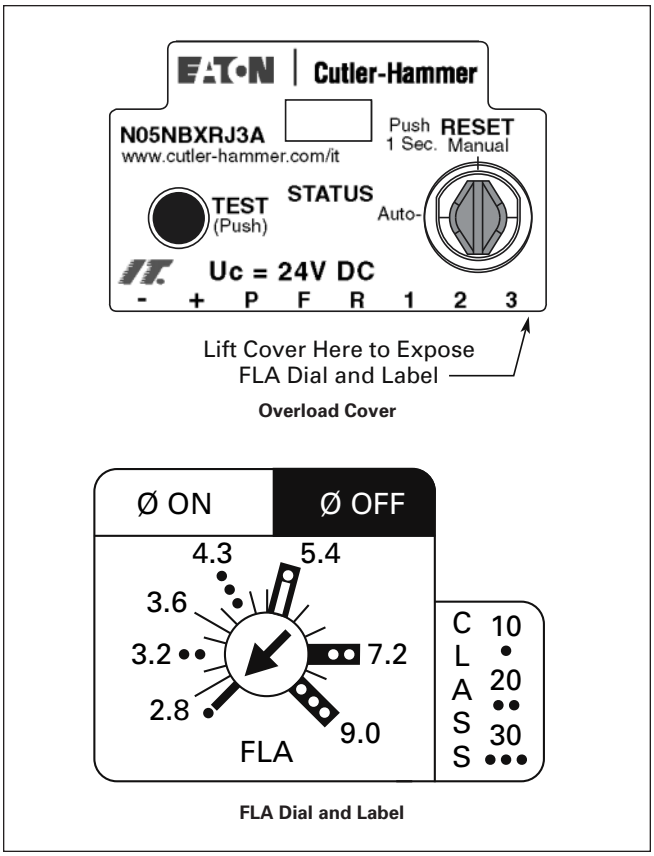

Figure 31.4-2. *IT.* Overload Cover, Dial and Label

Auxiliary Contacts

Auxiliary Contacts are available for mounting on Eaton's Cutler-Hammer Intelligent Technologies (***IT.***) Electro-Mechanical Contactors and Starters. The various choices available for non-reversing models are shown in **Table 31.4-2** and their ratings in **Table 31.4-4.** For reversing models, the number of auxiliaries indicated is for each of the contactors/starters in the assembly.

Table 31.4-2. Auxiliary Contact Availability — Sizes 00 – 5

Top Mounted (Maximum Auxiliaries per Contactor/Starter) ①						
Contactor/Starter Size					Contact Type	Catalog Number
Size 00, 0	Size 1	Size 2	Size 3, 4	Size 5		
3	3	3	3	—	1NO	**EMA13**
3	3	3	3	—	1NC	**EMA14**
2	2 ②	3	3	—	1NO-1NC	**EMA15**
2	2 ②	3	3	—	2NO	**EMA16**
2	2 ②	3	3	—	2NC	**EMA17**
2	3	3	3	3	Logic Level 1NO-1NC	**EMA70**

① For reversers, multiply quantities by two.
② Other combinations: Single, Dual, Single; Dual, Single, Dual; and Dual, Logic Level, Dual.

Table 31.4-3. NEMA A600 Ratings

Current	ac Voltage			
	120	240	480	600
Make and Interrupting Break	60 6	30 3	15 1.5	12 1.2
Continuous Thermal	10 10	10 10	10 10	10 10

Table 31.4-4. NEMA P300 Ratings

Current	dc Voltage	
	125	250
Make and Interrupting Break	1.1 1.1	.55 .55
Continuous Thermal	5 5	5 5

Table 31.4-5. NEMA Specifications

Description	Size 00, 0	Size 1	Size 2	Size 3, 4	Size 5
Overall Dimensions in Inches (mm) ① — *w* x *h* x *d*					
Non-reversing Contactor	1.80 x 4.40 x 2.40 (45.7 x 111.8 x 61.0)	2.10 x 4.40 x 2.40 (53.3 x 111.8 x 61.0)	3.00 x 5.90 x 3.10 (76.2 x 149.9 x 78.7)	4.10 x 8.00 x 3.50 (104.1 x 203.2 x 88.9)	5.50 x 13.90 x 7.00 (139.7 x 353.1 x 177.8)
Reversing Contactor	3.80 x 5.90 x 2.70 (96.5 x 149.9 x 68.6)	4.50 x 5.90 x 2.60 (114.3 x 149.9 x 66.0)	6.20 x 7.40 x 3.30 (157.5 x 188.0 x 83.8)	8.50 x 9.50 x 3.80 (215.9 x 241.3 x 96.5)	11.70 x 13.90 x 7.20 (297.2 x 353.1 x 182.9)
Non-reversing Starter	1.80 x 5.00 x 2.50 (45.7 x 127.0 x 63.5)	2.10 x 5.40 x 2.50 (53.3 x 137.2 x 63.5)	3.00 x 5.90 x 3.10 (76.2 x 149.9 x 78.7)	4.10 x 8.00 x 3.50 (104.1 x 203.2 x 88.9)	5.70 x 19.40 x 7.00 (144.8 x 492.8 x 177.8)
Reversing Starter	3.80 x 5.90 x 2.70 (96.5 x 149.9 x 68.6)	4.50 x 5.90 x 2.60 (114.3 x 149.9 x 66.0)	6.20 x 7.40 x 3.30 (157.5 x 188.0 x 83.8)	8.50 x 9.50 x 3.80 (215.9 x 241.3 x 96.5)	11.80 x 19.40 x 7.20 (299.7 x 492.8 x 182.9)
Mounting Hole Spacing in Inches (mm) — *w* x *h*					
Non-reversing Contactor	1.33 x 4.00 (33.8 x 101.6)	1.46 x 4.10 (37.1 x 104.1)	0.94 x 2.87 (23.9 x 72.9)	1.33 x 4.13 (33.8 x 104.9)	1.75 x 13.00 (44.5 x 330.2)
Reversing Contactor	3.15 x 5.35 (80.0 x 135.9)	3.15 x 5.35 (80.0 x 135.9)	5.51 x 6.89 (140.0 x 175.0)	7.87 x 9.06 (200.0 x 230.1)	7.82 x 13.00 (198.5 x 330.2)
Non-reversing Starter	1.33 x 4.62 (33.8 x 117.3)	1.46 x 5.04 (37.1 x 128.0)	0.94 x 2.87 (23.9 x 72.9)	1.33 x 4.13 (33.8 x 104.9)	1.75 x 18.30 (44.5 x 464.8)
Reversing Starter	3.15 x 5.35 (80.0 x 135.9)	3.15 x 5.35 (80.0 x 135.9)	5.51 x 6.89 (140.0 x 175.0)	7.87 x 9.06 (200.0 x 230.1)	7.82 x 18.30 (198.5 x 464.8)
Mounting Positions					
Panel-Vertical	Yes	Yes	Yes	Yes	Yes
Panel-Horizontal	Yes	Yes	Yes	Yes	Yes
DIN Rail Mountable	Yes ②	Yes ②	Yes ②	No	No
Weights in Lb. (kg)					
Non-reversing Contactor	0.7 (.31)	0.9 (.42)	2.8 (1.27)	6.7 (3.05)	20.0 (9.1)
Reversing Contactor	1.9 (.86)	2.6 (1.17)	6.9 (3.13)	16.9 (7.67)	48.0 (21.8)
Non-reversing Starter	0.9 (.40)	1.2 (.53)	2.9 (1.32)	7.1 (3.20)	27.0 (12.3)
Reversing Starter	2.0 (.90)	2.6 (1.20)	7.1 (3.20)	16.8 (7.60)	55.0 (25.0)
Mechanical Operating Rate					
Maximum	3/sec	3/sec	2/sec	2/sec	1/sec
Mechanical Life					
—	10,000,000	10,000,000	8,000,000	8,000,000	5,000,000
Electrical Life at 460 V ③					
AC-2, AC-3 (at max. amps.)	1,000,000 – 3,000,000	1,000,000 – 2,000,000	800,000 – 2,000,000	800,000 – 1,500,000	500,000 – 1,000,000 ④
AC-4 (at max. amps.)	30,000 – 90,000	40,000 – 80,000	25,000 – 60,000	20,000 – 40,000	15,000 – 30,000 ④
Insulation Voltage (Ui)					
—	690 V	690 V	690 V	690 V	690 V
Impulse Withstand Voltage (Uimp)					
—	6 kV	6 kV	6 kV	6 kV	6 kV

① Auxiliaries add approximately 1.0 inch (25.4 mm) to depth for single, 1.2 inch (30.5 mm) for dual.
② Non-reversing contactors and starters only.
③ See **Page 31.4-7**, Life-Load Curves, for maximum operations per frame size at various amperes.
④ Preliminary data.

Table 31.4-5. NEMA Specifications (Continued)

Description	Size 00, 0	Size 1	Size 2	Size 3, 4	Size 5
Finger Protection					
Front	IP20	IP20	IP20	IP20	IP20
At Terminals	IP10	IP10	IP00	IP00	IP00
At Terminals with max. size wire installed	IP20	IP10	IP10	IP00	IP00
Terminals L1, L2, L3/T1, T2, T3 ①					
1 Wire per Terminal (stranded or solid)	14 – 8 AWG (1.5 – 10 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)	14 – 1 AWG (1.5 – 35 mm^2)	6 – 250 kcmil (16 – 120 mm^2)	4 – 600 kcmil (16 – 300 mm^2)
2 Wires per Terminal (stranded or solid)	14 – 10 AWG (1.5 – 4 mm^2)	14 – 6 AWG (1.5 – 16 mm^2)	14 – 2 AWG (1.5 – 25 mm^2)	6 – 3/0 AWG (16 – 70 mm^2)	4 — 250 kcmil (16 — 120 mm^2)
Strip Length	.45" (11 mm)	.5" (12 mm)	.7" (18 mm)	.8" (21 mm)	1.5" (40 mm)
Torque (max.)	20 lb-in (2.2 Nm) for 14 – 10 AWG (1.5 – 6 mm^2); 25 lb-in (2.8 Nm) for 8 AWG (10 mm^2)	35 lb-in (4.0 Nm) for 14 – 10 AWG (1.5 – 6 mm^2); 40 lb-in (4.5 Nm) for 8 AWG (10 mm^2); 45 lb-in (5.0 Nm) for 6 – 4 AWG (16 mm^2)	45 lb-in (5.0 Nm) for Single 14 – 8 AWG (1.5 – 10 mm^2); 100 lb-in (11 Nm) for Single 6 – 1 AWG (16 – 35 mm^2) and Dual Wire Combinations	250 lb-in (28 Nm)	550 lb-in (62 Nm)
Driver	2.5 mm Hex Key	3 mm Hex Key	5/32" (4 mm) Hex Key	5/16" (8 mm) Hex Key	5/16" (8 mm) Hex Key
Operation Performance					
Coil Voltage (nominal)	24 Vdc	24 Vdc	24 Vdc	24 Vdc	24 Vdc
Coil Operating Voltage Range (Vdc)	20 – 28	20 – 28	20 – 28	20 – 28	20 – 28
Control Terminals					
(- and +) 1 Wire per Terminal	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)
(- and +) 2 Wires per Terminal	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)
(P, F, R, 1, 2, 3) 1 Wire per Terminal	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)
(P, F, R, 1, 2, 3) 2 Wires per Terminal	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)
Torque (max.)	4.5 lb-in (.5 Nm)	4.5 lb-in (.5 Nm)	4.5 lb-in (.5 Nm)	4.5 lb-in (.5 Nm)	4.5 lb-in (.5 Nm)
Strip Length	.25 (7 mm)	.25 (7 mm)	.25 (7 mm)	.25 (7 mm)	.25 (7 mm)
Driver	.13 (3.5 mm) Flat	.13 (3.5 mm) Flat	.13 (3.5 mm) Flat	.13 (3.5 mm) Flat	.13 (3.5 mm) Flat
Temperature ②					
Operating	-40° to +149°F (-40° to +65°C)	-40° to +149°F (-40° to +65°C)	-40° to +149°F (-40° to +65°C)	-40° to +149°F (-40° to +65°C)	-40° to +149°F (-40° to +65°C)
Storage	-58° to +176°F (-50° to +80°C)	-58° to +176°F (-50° to +80°C)	-58° to +176°F (-50° to +80°C)	-58° to +176°F (-50° to +80°C)	-58° to +176°F (-50° to +80°C)
Environmental					
Shock/Vibration	15G/5G	15G/5G	15G/5G	15G/5G	15G/5G ③
Altitude ②	6600 Ft (2000 m)	6600 Ft (2000 m)	6600 Ft (2000 m)	6600 Ft (2000 m)	6600 Ft (2000 m)
Pull-In Time (ms) at 24 Vdc					
Excl. Debounce Time	15	15	25	30	70 – 200 ③
Incl. Debounce Time	75	80	88	95	120 – 250 ③
Dropout Time (ms) at 24 Vdc					
Excl. Debounce Time	5	5	12	15	50 – 150 ③
Incl. Debounce Time	65	70	75	80	70 – 200 ③

① Use Class B 75°C copper wire only (or 90°C copper wire sized for 75°C operation per NEC)

② Consult factory for higher ratings.

③ Preliminary data.

Note: At other temperatures expressed in °C, for either inrush or sealed, use the 20°C value from the table in the following:

Watts = W_{20} [1.1 – .005(T) and
Amperes = A_{20} [1.1 – .005(T)]

For example, inrush requirements for a D Frame Starter at -25°C would be:
Watts = 130 [1.1 – .005 (-25)] = 160
Amperes = 5.4 [1.1 – .005 (-25)] = 6.6

Note: Response time for Control Inputs = Debounce Time.
The time between operating forward and reverse must be greater than the Debounce Time.

Table 31.4-6. 24 Vdc Power Supply Requirements at 68°F (20°C) (see Note at bottom left)

Contactor/Starter Size		Sealed In		Inrush		
Catalog Number ④	Size	Wattage	Amperes	Wattage	Amperes	Duration (msecs)
N_11B_ _X3N	00, 0	3.7	.15	80	3.3	50
N_01B_ _ _3A	00, 0	3.2	.13	80	3.3	50
N_11C_ _X3N	1	4.2	.18	90	3.8	50
N_01C_ _ _3A	1	3.6	.15	90	3.8	50
N_ _1D_ _ _3_	2	5.0	.21	130	5.4	65
N_ _1E_ _ _3_	3, 4	5.6	.23	140	5.8	85
N_ _1F_ _ _3_	5	8.4	.35	200	8.3	250
N_01F_ _ _3_	5	9.1	.38	200	8.3	250

④ _ indicates missing digit/character of the Catalog Number; may have multiple values.

Electrical Life — AC-1, AC-2, AC-3 and AC-4 Utilization Categories

Table 31.4-7. Utilization Categories

The International Electrotechnical Commission (IEC) has developed utilization categories for contactors and auxiliary contacts. The categories describe the type of electrical load and the conditions for making and breaking the current.	
Category	**Typical Application**
AC-1	Non-inductive or slightly inductive loads: Resistance furnaces, heating.
AC-2	Slip-ring motors: Starting and stopping of running motors
AC-3	Squirrel cage motors: Starting, switching off motors during running (motors in most industrial applications typically fall into this category).
AC-4	Squirrel cage motors: Starting, plugging ①, inching ② (very few applications in industry are totally AC-4).

① Plugging is stopping or reversing the motor rapidly by reversing the connections while the motor is running.
② Inching or jogging is energizing the motor once or repeatedly for short durations to obtain small movements of the motor driven load.

Life Load Curves — Eaton's Cutler-Hammer *IT.* Electromechanical Series NEMA contactors have been designed and manufactured for superior life performance. All testing has been based on requirements as found in IEC 60947-4-1 and conducted by us. When selecting a contactor, the specifier must give attention to the specific load, utilization category and the required electrical life. For a definition of Utilization Categories, see **Table 31.4-7** above.

Note: AC-3 tests are conducted at rated device currents and AC-4 tests are conducted at six-times rated device currents. All tests have been run at 600 V, 60 Hz.

Actual application life may vary, depending on environmental conditions and application duty cycle.

Contactor Choice —

- Decide what utilization category the application is and choose the appropriate curve from **Figure 31.4-3**.
- Locate the intersection of the life-load curve with the operational current (Ie) of the application, as found on the horizontal axis.
- Read the estimated contact life along the vertical axis in number of operations.

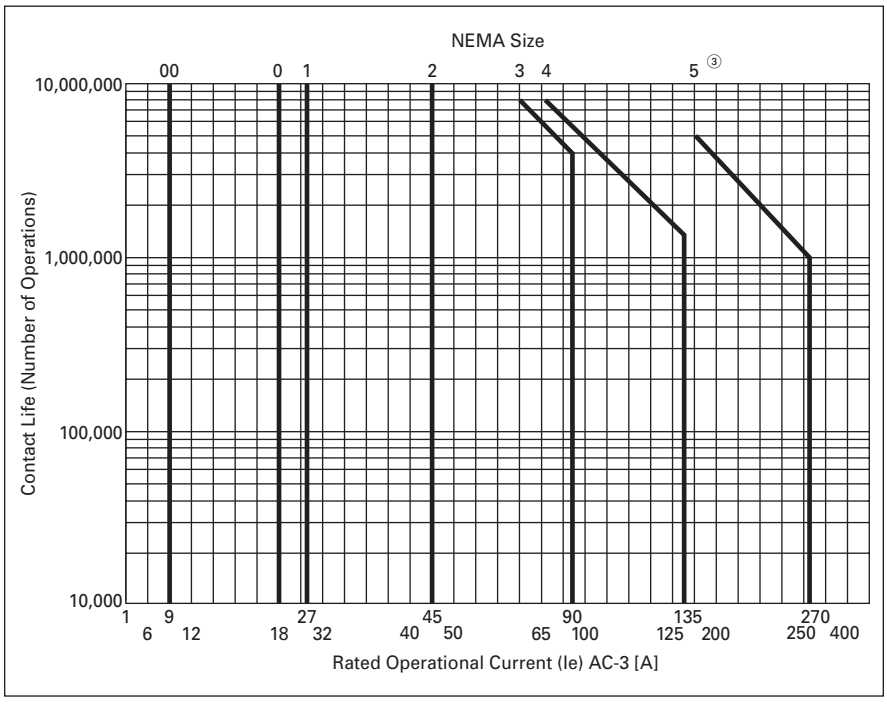

Figure 31.4-3. Electrical Life — AC-3 Utilization Category

③ Preliminary data.

Trip Times

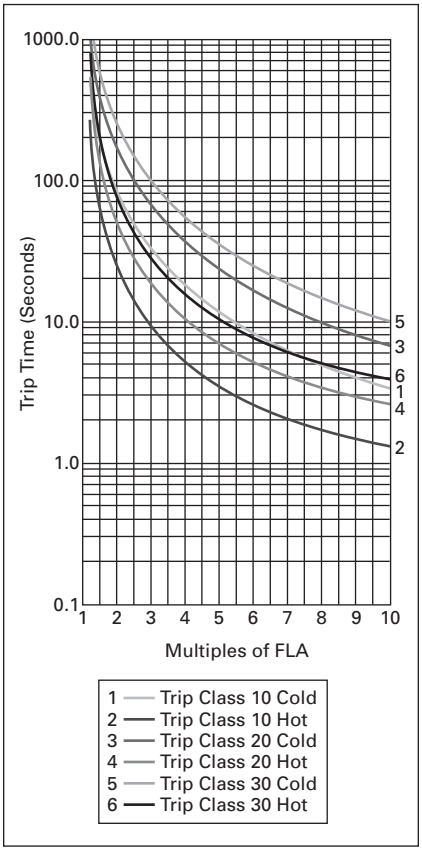

Figure 31.4-4. Class 10, 20 and 30 Trip Curves

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Wiring Diagrams

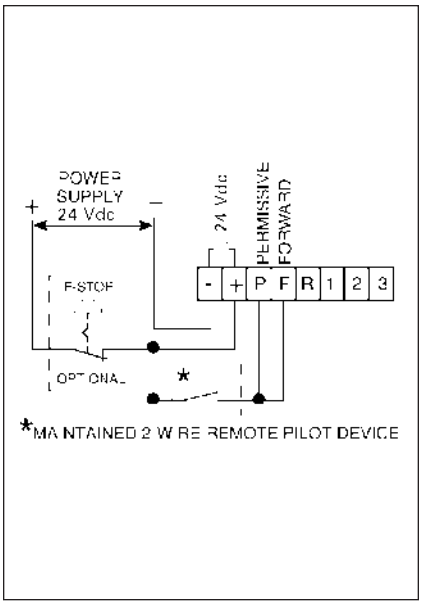

Figure 31.4-5. 2-Wire Control Non-Reversing Contactor Terminal Connections

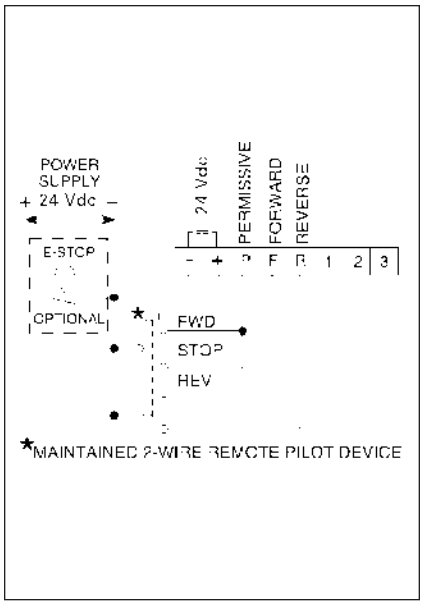

Figure 31.4-7. 2-Wire Control Reversing Contactor Terminal Connections — B- to E-Frames

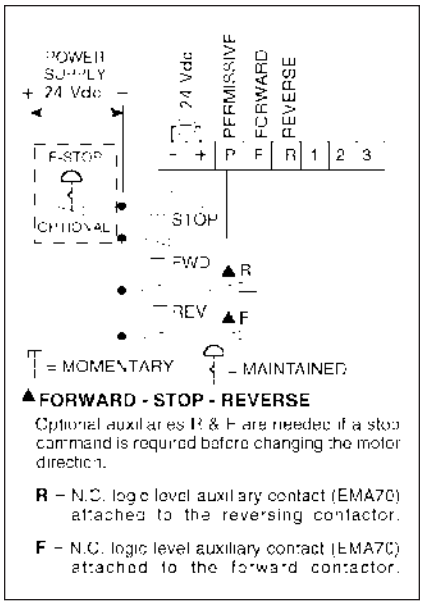

Figure 31.4-9. 3-Wire Control Reversing Contactor Terminal Connections — A-Frame

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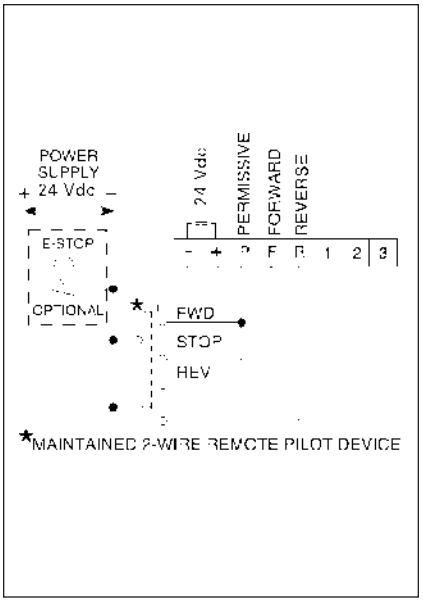


Figure 31.4-6. 2-Wire Control Reversing Contactor Terminal Connections — A-Frame

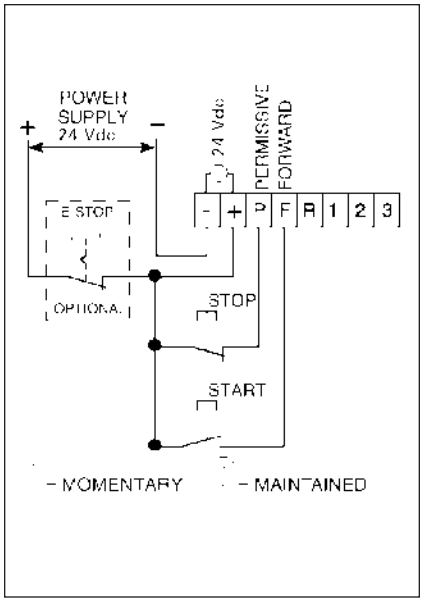


Figure 31.4-8. 3-Wire Control Non-Reversing Contactor Terminal Connections

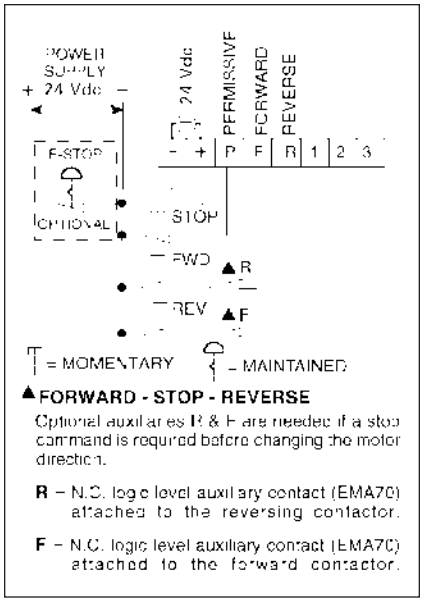


Figure 31.4-10. 3-Wire Control Reversing Contactor Terminal Connections — B- to E-Frames

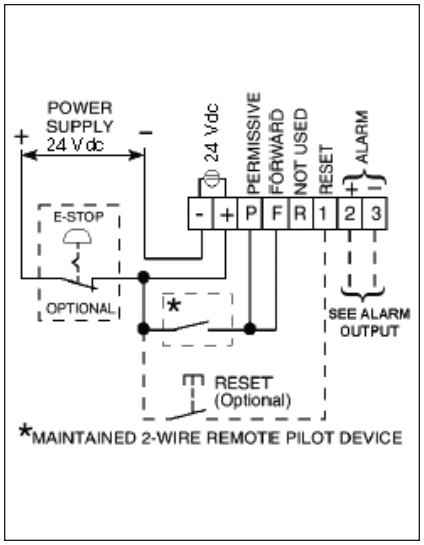


Figure 31.4-11. 2-Wire Control Non-Reversing Starter Terminal Connections

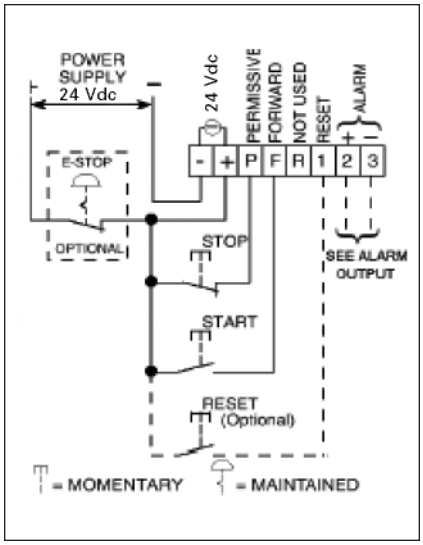


Figure 31.4-13. 3–Wire Control Non-Reversing Starter Terminal Connections — B- to E-Frames

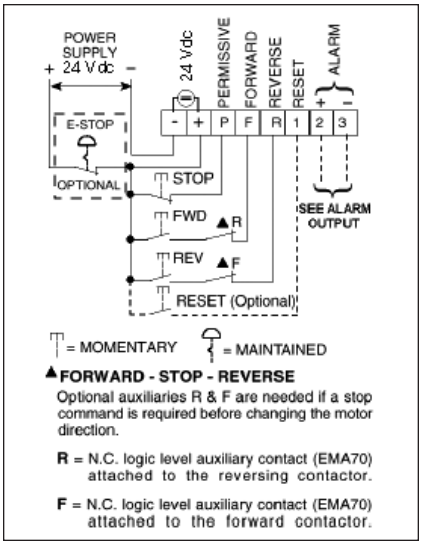


Figure 31.4-14. 3-Wire Control Reversing Starter Terminal Connections — B- to E-Frames

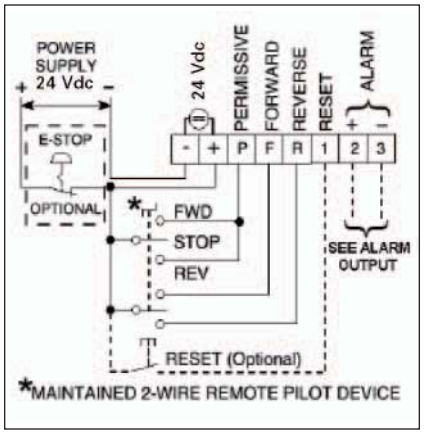


Figure 31.4-12. 2-Wire Control Reversing Starter Terminal Connections — B- to E-Frames

Table 31.4-8. *IT.* Low Energy Pilot Device Pushbutton Contact Blocks

Pilot Device Recommended Cutler-Hammer Contact Blocks			
Circuit	**Catalog Number**	**Circuit**	**Catalog Number**
1NC 1NO 1NO	**E22B1E** **E22B2E** **E30KLAE1**	2NC 1NC 1NO	**E30KLAE5** **10250T51E** **10250T53E**
1NC 1NO, 1NC 2NO	**E30KLAE2** **E30KLAE3** **E30KLAE4**	1NO, 1NC 2NC 2NO	**10250T1E** **10250T3E** **10250T2E**

Note: Contact blocks with reliability "nibs" are also suitable.

Table 31.4-9. *IT.* Control Terminal Block Wire Size, Lug Torque and Tool Size

Control Terminal Block Wiring								
Contactor/ Starter Size			**Wire Size Range (AWG) mm²**			**Torque Lb-in (N-m)**	**Terminal Type**	**Tool**
Type	**Frame**	**mm**	**P, F, R, 1, 2, 3** ①	**- and +**	**Strip Length**			
All	All	All	1 of (22 – 12) 0.5 – 2.5 or 2 of (18 – 14) 0.75 – 1.5	1 of (14 – 12) 1.5 – 2.5 or 2 of 1.5 (14)	.25 (7 mm)	4.5 (0.5)	Box Lug Pressure Type	Slotted 0.13 (3.5 mm) ①

① When present.

Enclosed Box Selection

Table 31.4-10. Type 1 *IT.* Contactors

NEMA Size	Box No.	Shipping Weight Lbs. (kg)
Non-reversing Contactors without PSS Power Supply		
00	1	3 (1.4)
0	1	3 (1.4)
1	1	3 (1.4)
2	2	5 (2.3)
3	2	10 (4.5)
4	2	10 (4.5)
5	3	32 (15)
Reversing Contactors without PSS Power Supply		
00	1	4 (1.8)
0	1	4 (1.8)
1	1	6 (2.7)
2	2	5 (2.3)
3	3	20 (9.1)
4	3	20 (9.1)
5	3	52 (24)
Non-reversing Contactors with PSS Power Supply		
00	2	4 (1.8)
0	2	4 (1.8)
1	2	4 (1.8)
2	2	6 (2.7)
3	3	12 (5.4)
4	3	12 (5.4)
5	3	33 (15)
Reversing Contactors with PSS Power Supply		
00	2	5 (2.3)
0	2	5 (2.3)
1	2	5 (2.3)
2	3	10 (4.5)
3	3	21 (10)
4	3	22 (10)
5	3	54 (25)

Table 31.4-11. Type 3R, 4/4X, 12 *IT.* Contactors

NEMA Size	Box No.	Shipping Weight Lbs. (kg)
Non-reversing without PSS Power Supply		
00, 0	5	12 (5.4)
1	5	12 (5.4)
2	5	14 (6.4)
3	8	32 (15)
4	8	41 (19)
5	10	99 (45)
Non-reversing with PSS Power Supply		
00, 0	5	13 (5.9)
1	6	13 (5.9)
2	6	15 (6.8)
3	8	34 (15)
4	8	43 (20)
5	10	101 (46)
Reversing without PSS Power Supply		
00, 0	6	14 (6.4)
1	6	14 (6.4)
2	6	17 (7.7)
3	8	40 (18)
4	9	48 (22)
5	10	125 (57)

Table 31.4-12. Type 1 *IT.* Non-combination Starters

NEMA Size	Box No.	Shipping Weight Lbs. (kg)
Non-reversing Non-combination Starters		
00	2	8 (3.6)
0	2	8 (3.6)
1	2	8 (3.6)
2	2	11 (5.0)
3	4	16 (7.3)
4	4	16 (7.3)
5	4	36 (16)
Reversing Non-combination Starters		
00	3	9 (4.1)
0	3	9 (4.1)
1	3	9 (4.1)
2	3	15 (6.8)
3	4	24 (11)
4	4	24 (11)
5	4	65 (30)

Table 31.4-13. Type 3R, 4/4X, 12 *IT.* Non-combination Starters

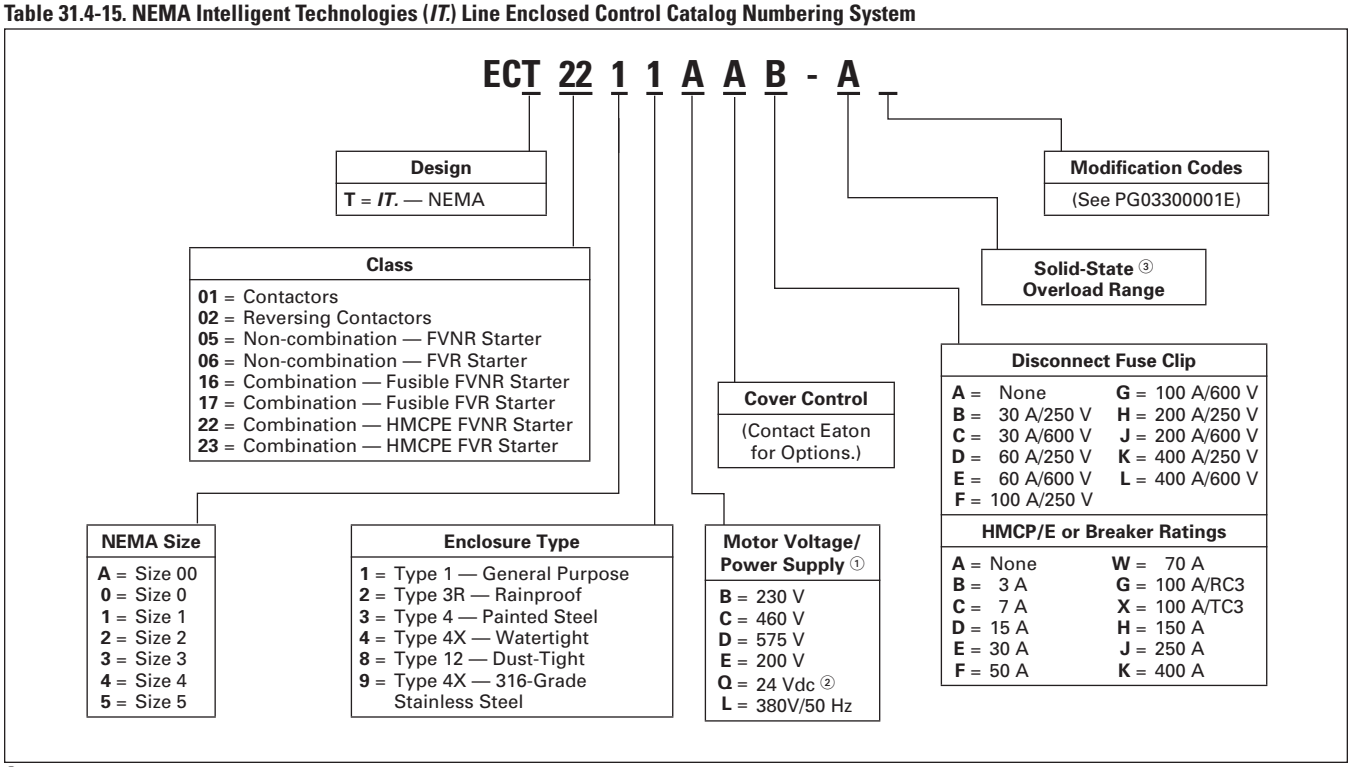
NEMA Size	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Non-combination Starters		
00, 0	5	8 (3.6)
1	5	9 (4.1)
2	7	12 (5.4)
3	8	38 (17)
4	8	38 (17)
5	10	110 (50)
Reversing Non-combination Starters		
00, 0	3	10 (4.5)
1	3	11 (5.0)
2	3	18 (8.2)
3	4	32 (15)
4	4	32 (15)
5	4	92 (42)

Table 31.4-14. Type 1 *IT.* Combination Starters

NEMA Size	Box No.	Shipping Wt. Lbs. (kg)
Non-reversing Combination		
00, 0	A	35 (16)
1	A	35 (16)
2	A	36 (16)
3	C	60 (27)
4 (HMCP)	C	60 (27)
4 (Disconnect Switch)	E	120 (54)
5	E	140 (64)
Reversing Combination		
00, 0	B	36 (16)
1	B	36 (16)
2	B	37 (17)
3	C	68 (31)
4	E	68 (31)
5	F1E	167 (76)

Catalog Number Selection

Table 31.4-15. NEMA Intelligent Technologies (*IT.*) Line Enclosed Control Catalog Numbering System


ECT 22 1 1 A A B - A
Design
T = IT. — NEMA
Class
01 = Contactors
02 = Reversing Contactors
05 = Non-combination — FVNR Starter
06 = Non-combination — FVR Starter
16 = Combination — Fusible FVNR Starter
17 = Combination — Fusible FVR Starter
22 = Combination — HMCPE FVNR Starter
23 = Combination — HMCPE FVR Starter
NEMA Size
A = Size 00
0 = Size 0
1 = Size 1
2 = Size 2
3 = Size 3
4 = Size 4
5 = Size 5
Enclosure Type
1 = Type 1 — General Purpose
2 = Type 3R — Rainproof
3 = Type 4 — Painted Steel
4 = Type 4X — Watertight
8 = Type 12 — Dust-Tight
9 = Type 4X — 316-Grade Stainless Steel
Motor Voltage/ Power Supply ①
B = 230 V
C = 460 V
D = 575 V
E = 200 V
Q = 24 Vdc ②
L = 380V/50 Hz
Cover Control
(Contact Eaton for Options.)
Solid-State ③ Overload Range
Disconnect Fuse Clip
A = None
B = 30 A/250 V
C = 30 A/600 V
D = 60 A/250 V
E = 60 A/600 V
F = 100 A/250 V
G = 100 A/600 V
H = 200 A/250 V
J = 200 A/600 V
K = 400 A/250 V
L = 400 A/600 V
HMCP/E or Breaker Ratings
A = None
B = 3 A
C = 7 A
D = 15 A
E = 30 A
F = 50 A
W = 70 A
G = 100 A/RC3
X = 100 A/TC3
H = 150 A
J = 250 A
K = 400 A
Modification Codes
(See PG03300001E)

① If CPT is selected, Power Supply to be 120 Vac – 24 Vdc.
② Power supply omitted.
③ See **Table 31.4-16**, Solid-State Overload Range Codes.

Table 31.4-16. *IT.* Solid-State Overload Range Codes

FLA Range	Size						
	00	0	1	2	3	4	5
.25 – .80	**A**	**A**	**A**	—	—	—	—
.59 – 1.9	**B**	**B**	**B**	—	—	—	—
1.4 – 4.4	**C**	**C**	**C**	—	—	—	—
2.8 – 9.0	**D**	**D**	**D**	—	—	—	—
5.0 – 16	—	—	**F**	—	—	—	—
6.3 – 20	—	**G**	—	—	—	—	—
8.4 – 27	—	—	**H**	—	—	—	—
10 – 32	—	**J**	—	—	—	—	—
14 – 45	—	—	—	**K**	—	—	—
16 – 50	—	—	**L**	—	—	—	—
28 – 90	—	—	—	—	**M**	—	—
31 – 100	—	—	—	**N**	—	—	—
42 – 135	—	—	—	—	—	**P**	—
63 – 200	—	—	—	—	—	**R**	—
84 – 270	—	—	—	—	—	—	**S**
131 – 420	—	—	—	—	—	—	**T**

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Low Voltage Reduced Voltage

Starter Selection Guide

In general, the application will determine the type of starter required. In cases where more than one type starter will meet the application requirements, reference to the table below will show which starter is best suited for the application.

Table 31.5-1. Reduced Voltage Starting Characteristics and Index

Starter Type	Starting Characteristics Expressed in % of Rated Values (Approximate)				Remarks	Page
	Motor Voltage	Motor Current	Line Current	Torque		
Autotransformer Class ECA42						31.5-2
80% Tap	80	80	67 ①	64	The adjustable voltage taps permit wide adjustment of characteristics in the field.	
65% Tap	65	65	45 ①	42		
50% Tap	50	50	28 ①	25		
Part Winding Class ECA45	100	65	65	50	Requires part winding closed transition motor. A nine-lead 230/460-volt dual voltage motor may be used in 230-volt applications. Closed transition.	31.5-3
Wye-Delta Class ECA48 Class ECA51	100	33	33	33	Requires delta wound motor with wye connections. Ideal for long accelerations. Closed transition is available.	31.5-4

① Includes autotransformer magnetizing current.

General Application

The following factors should be considered when applying reduced-voltage starters to a squirrel cage motor-driven load.

1. The motor characteristics which will satisfy the starting requirements of the load.
2. The source of power and the effect the motor starting current will have on the line voltage.
3. The load characteristics and the effect the motor starting torque will have on the driven parts during acceleration.

The starter protection required to protect the load, motor, starter, cables and power source during overload, undervoltage and fault conditions.

A typical NEMA B motor started with full voltage will develop as much as 150% full-load torque when started with a starting current of around 600% full-load current. These values may exceed the mechanical limitations of the load or electrical limitations of the source, or both.

A reduced-voltage or reduced-inrush starter will reduce both starting current and starting torque. Care must be taken when meeting power company limitations that the motor will produce sufficient torque to accelerate the load to near rated speed.

Part-winding starters are suited to low starting torque loads such as fans, blowers and m-g sets. Autotransformer starters should be used with "hard to start" loads such as reciprocating compressors, grinding mills, and pumps. Wye-Delta starters are applicable to high inertia loads with long acceleration times which as centrifugal compressors and centrifuges.

All starters, in addition to overload protection, will provide either low voltage release or low voltage protection depending upon the pilot device used with the starter. Low voltage release, where power is applied to the motor after a power failure, can be obtained by using a 2-wire pilot device (temperature, switch, etc.). Low voltage protection, where power is not applied to the motor after a power failure until restarted by an operator, can be obtained by using 3-wire control such as START STOP pushbuttons.

Closed transition Wye-Delta types require adequate ventilation to remove resistor heat.

Eaton also offers a line of solid-state reduced-voltage starters known as Easy-start.

Solid-state starters are ideally suited for many loads including conveyor applications since they provide controlled acceleration from zero to full load.

UL listing — Combination E176513, Non-Combination E19224.

31

Starting Characteristics

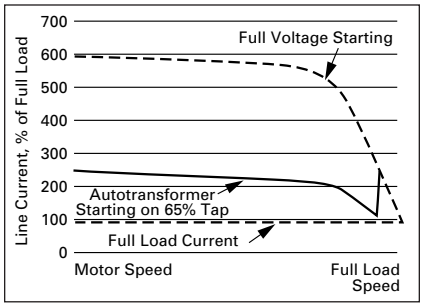

Figure 31.5-1. Autotransformer Starting

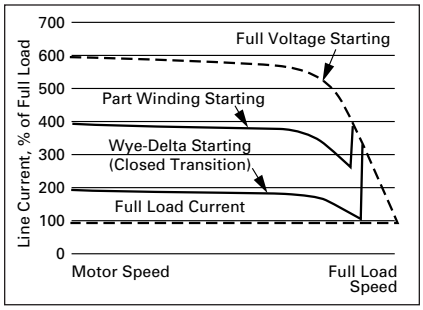

Figure 31.5-2. Wye-Delta or Part Winding Starting

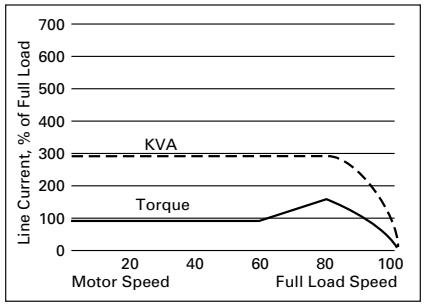

Figure 31.5-3. Solid-State Starter

Description

Autotransformer type starters are the most widely used reduced-voltage starter because of their efficiency and flexibility. All power taken from the line, except transformer losses, is transmitted to the motor to accelerate the load. Taps on the transformer allow adjustment of the starting torque and inrush to meet the requirements of most applications. The following characteristics are produced by the three voltage taps:

Table 31.5-2. Starting Characteristics

Tap	Starting Torque % Locked Torque	Line Inrush % Locked Ampere
50% ①	25%	28% ②
65%	42%	45% ②
80%	64%	67% ②

① Not included 50 hp and below.
② Includes transformer magnetizing current.

Closed transition is standard on all sizes ensuring a smooth transition from reduced to full voltage. Since the motor is never disconnected from the line there is no interruption of line current which can cause a second inrush during transition.

Duty cycle of these starters is as follows: up to 200 hp, 15 seconds on each 4 minutes for 1 hour, repeated after 2 hours. Over 200 hp, three periods of 30 seconds ON, 30 seconds OFF repeated after 1 hour.

Design Features

Contactors — (1S) (2S) (Run)

A 3-pole (1S) ③ and a 3-pole contactor (2S) connect the motor to the autotransformer for reduced-voltage starting (see **Table 31.5-3** for size).

A 3-pole contactor (Run) bypasses the autotransformer and connects the motor for full-voltage across-the-line running (see **Table 31.5-3** for size).

Table 31.5-3. NEMA Contactor Size Guidelines within Autotransformer Starters

Maximum hp	NEMA Size			
	Starter	Contactor		
		Run	Starting	
			(1S) (3-Pole)	(2S) (3-Pole)
230 Volts, 60 Hz				
15	2	2	2	2
30	3	3	3	3
50	4	4	4	4
100	5	5	5	5
200	6	6	6	6
300	7	7	6 ③	6
450	8	8	7 ③	7
460 – 575 Volts, 60 Hz				
25	2	2	2	2
50	3	3	3	3
100	4	4	4	4
200	5	5	5	5
400	6	6	6	6
600	7	7	6 ③	6
900	8	8	7 ③	7

③ 1S is 2-pole on sizes 7 and 8.

Operation (Refer to Schematic Diagram)

Closing the START button or other pilot device energizes the start contactor (1S). The interlock (1S) closes, energizing the timing relay (TR) and contactor (2S) which seal in through the interlock (2S). With the (1S) and (2S) contactors closed, the motor is connected through the autotransformer for reduced-voltage start. After a preset time interval, the (TR_{TO}) contacts time open, de-energizing contactor (1S) and connecting the autotransformer as a reactor in series with the motor. Interlock (1S) immediately energizes the run contactor (R) which seals in through its interlock (R). The run contacts are now closed, and the motor is running at full voltage. Start contactor (2S) and relay (TR) are de-energized when interlock (R) opens.

An overload, opening the STOP pushbutton or other pilot device de-energizes the (R) contactor removing the motor from the line.

Other Types

Autotransformer starters are also available in combination and reversing types.

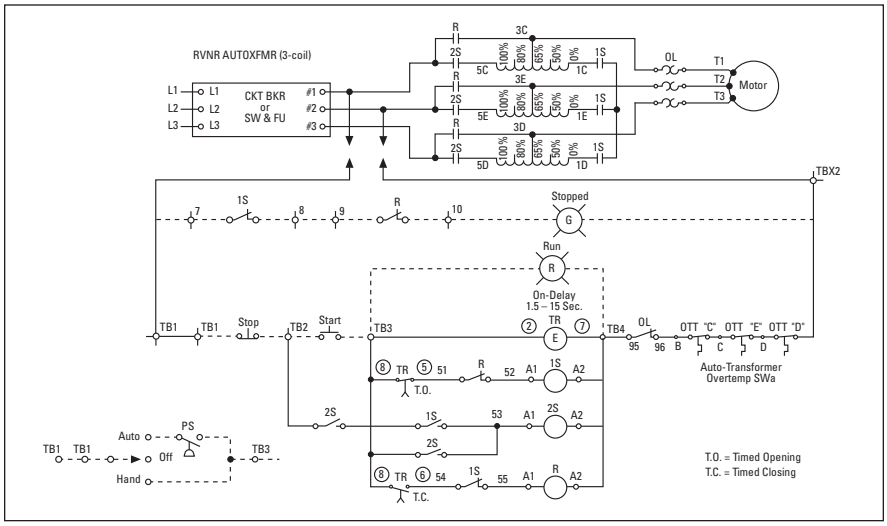

Figure 31.5-4. Typical Schematic Diagram

Table 31.5-4. Type 1, 3R, 4/4X, 12 Freedom Reduced Voltage Enclosures

Size	Type 1		Type 3R, 4X, 12	
	Box No.	Shipping Wt. Lbs. (kg)	Box No.	Shipping Wt. Lbs. (kg)
Class 42: Autotransformer — Non-combination **Class 43: Autotransformer — with Disconnect** **Class 44: Autotransformer — with HMCP**				
2 – 4	E2	124 (56)	E2	149 (68)
5	F1E	885 (402)	F1E	1010 (459)
6 ④	F1E	1220 (554)	F1E	1345 (611)
6 ③	F2E	1400 (636)	F2E	1525 (692)
7	F2E	⑤	F2E	⑤
8	F2E	⑤	F2E	⑤
9	⑤	⑤	⑤	⑤

④ Non-combination and breaker.
⑤ Consult factory.

For enclosure box dimensions, refer to Page 31.7-3.

Description

Part-Winding starting provides convenient, economical one-step acceleration at reduced current where the power company specifies a maximum or limits the increments of current drawn from the line. These starters can be used with nine-lead dual-voltage motors on the lower voltage and with special part-winding motors designed for any voltage. When used with dual-voltage motors, it should be established that the torque produced by the first half-winding will accelerate the load sufficiently so as not to produce a second undesirable inrush when the second half-winding is connected to the line. Most motors will produce a starting torque equal to between 1/2 to 2/3 of NEMA standard values with half of the winding energized and draw about 2/3 of normal line current inrush.

Design Features

Contactors — (1M) (2M)

A 3-pole contactor (1M) connects only the first half-winding of the motor for reduced inrush current on starting (see table below for size). A 3-pole contactor (2M) connects the second half-winding of the motor for running (see table below for size).

Table 31.5-5. NEMA Contactor Size Guidelines within Part Winding Starters

Maximum hp	NEMA Size		
	Starter	Contactor	
		(1M)	(2M)
230 Volts, 60 Hz			
15	1 PW	1	1
25	2 PW	2	2
50	3 PW	3	3
75	4 PW	4	4
150	5 PW	5	5
300	6 PW	6	6
460 – 575 Volts, 60 Hz			
15	1 PW	1	1
40	2 PW	2	2
75	3 PW	3	3
150	4 PW	4	4
350	5 PW	5	5
600	6 PW	6	6

Overload Relay — (OL)

Two 3-pole Type B overload relays provide starting and running overcurrent protection.

Timing Relay — (TR)

An electrically operated pneumatic relay provides accurate, adjustable start-to-run transfer timing.

Other Types

Part-winding Type ECN45 starters are also available in combination (Type 46 and 47), reversing and three-point (primary resistor) types.

Operation (Refer to Schematic Diagram)

Closing the START button or other pilot device energizes the start contactor (1M) which seals in through its interlock (1M) and energizes the timer (TR). The (1M) contacts connect the first half-winding of the motor across the line. After a preset time interval, the timer (TR_{TC}) contact closes energizing contactor (2M). The (2M) contact connects the second half-winding of the motor across-the-line.

Opening the STOP button or other pilot device de-energizes contactors (1M), (2M) and timer (TR), removing the motor from the line.

Table 31.5-6. Contactor Sequence

Contactor	Start	Run
1M	●	●
2M	—	●

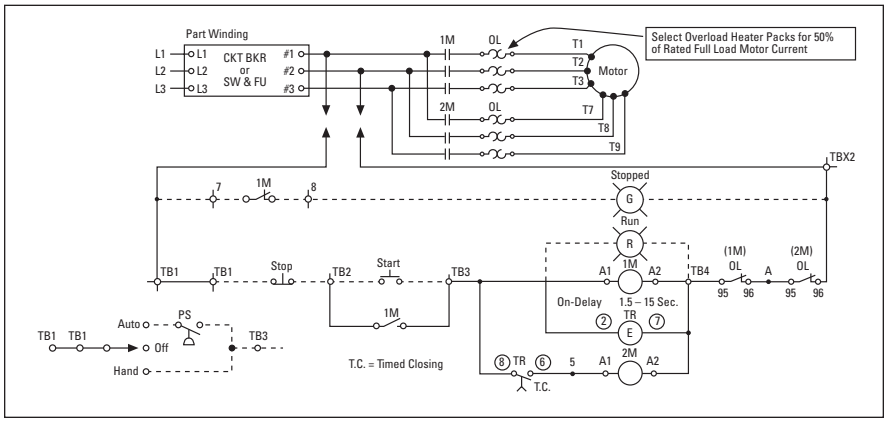

Figure 31.5-5. Typical Schematic Diagram

Table 31.5-7. Type 1, 3R, 4/4X, 12 Freedom Reduced Voltage Enclosures

Size	Type 1		Type 3R, 4X, 12	
	Box No.	Shipping Wt. Lbs. (kg)	Box No.	Shipping Wt. Lbs. (kg)
Class 45: Part Winding — Non-combination				
2PW	3	25 (11)	7	75 (34)
3PW – 4PW	9	47 (21)	9	95 (43)
5PW	E	125 (47)	E	180 (82)
6PW	F1E	780 (354)	F1E	880 (400)
7PW	F2E	①	F2E	①
8PW	F2E	①	F2E	①
Class 46: Part Winding — with Disconnect **Class 47: Part Winding — with Thermal Magnetic Trip Circuit Breaker**				
2PW	C	68 (31)	C	88 (40)
3PW	D	162 (74)	D	190 (86)
4PW	E	230 (104)	E	270 (123)
5PW	F1E	440 (200)	F1E	530 (241)
6PW ②	F1E	440 (200)	F1E	620 (281)
6PW ③	F2E	515 (234)	F2E	①
7PW	F2E	①	F2E	①
8PW	F2E	①	F2E	①

① Consult factory.
② Non-combination and breaker.
③ Fusible.

For enclosure box dimensions, refer to Page 31.7-3.

Description

Wye-Delta type starters are applied extensively to industrial air conditioning installations because they are particularly suited for starting motors driving high inertia loads with resulting long acceleration times. They are not, however, limited to this application. When six- or 12-lead delta-connected motors are started wye-connected, approximately 58% of line voltage is applied to each winding and the motor develops 33% of full-voltage starting torque and draws 33% of normal locked-rotor current from the line. When the motor is accelerated, it is reconnected for normal data operation.

Design Features

Contactors — (1S) (1M) (2S) (2M)

A 3-pole contactor (1S) ① shorts the motor leads T4-T5-T6 during starting to connect motor in wye (see **Table 31.5-8** for size).

A 3-pole contactor (1M) energizes motor leads T1-T2-T3 for both wye and delta connections (see **Table 31.5-8** for size).

A 3-pole contactor (2S) connects resistors in series with the motor windings during the start-to-run transition period (see **Table 31.5-8** for size).

A three-pole contactor (2M) energizes the motor leads T4-T5-T6 during running to connect the motor in delta (see **Table 31.5-8** for size).

Table 31.5-8. NEMA Contactor Size Guidelines

Max. hp	NEMA Size				
	Starter	Contactor			
		(1M)	(2M)	(1S)	(2S)
230 Volts, 60 Hz					
10	1 YD	1	1	1	1
25	2 YD	2	2	2	1
50	3 YD	3	3	3	1
75	4 YD	4	4	4	2
150	5 YD	5	5	4	3
300	6 YD	6	6	5	4
500	7 YD	7	7	6 ①	5
800	8 YD	8	8	7 ①	6
460 – 575 Volts, 60 Hz					
15	1 YD	1	1	1	1
40	2 YD	2	2	2	1
75	3 YD	3	3	3	1
150	4 YD	4	4	4	2
300	5 YD	5	5	4	3
700	6 YD	6	6	5	4
1000	7 YD	7	7	6 ①	5
1500	8 YD	8	8	7 ①	6

① 1S is 2-pole on sizes 7 and 8.

Operation (Refer to Schematic Diagram)

Closing the START button or other pilot device energizes contactor (1S) whose contacts connect the motor in a wye connection. Interlock (1S) closes, energizing contactor (1M) and timer (TR). The (1M) contacts energize the motor windings in a wye. After a preset time interval, timer (TR_{TC}) contact closes energizing contactor (2S). Interlock (2S) opens, dropping out contactor (1S). The motor is now energized in series with the resistors. Interlock (1S) closes, energizing contactor (2M), bypassing the resistors and energizing the delta connected motor at full voltage. Interlock opens, de-energizes the timer (TR) opening timer (TR_{TC}) thus energizing contactor (2S).

An overload, opening the STOP button or other pilot device de-energizes contactors (1M) and (2M), removing the motor from the line. (TRP) de-energizes and locks out the control circuit if the duty cycle of the transition resistors is exceeded.

Wye-Delta Class ECN51 closed transition starters are also available in combination types and Class ECN48 open transition non-combination and combination starters.

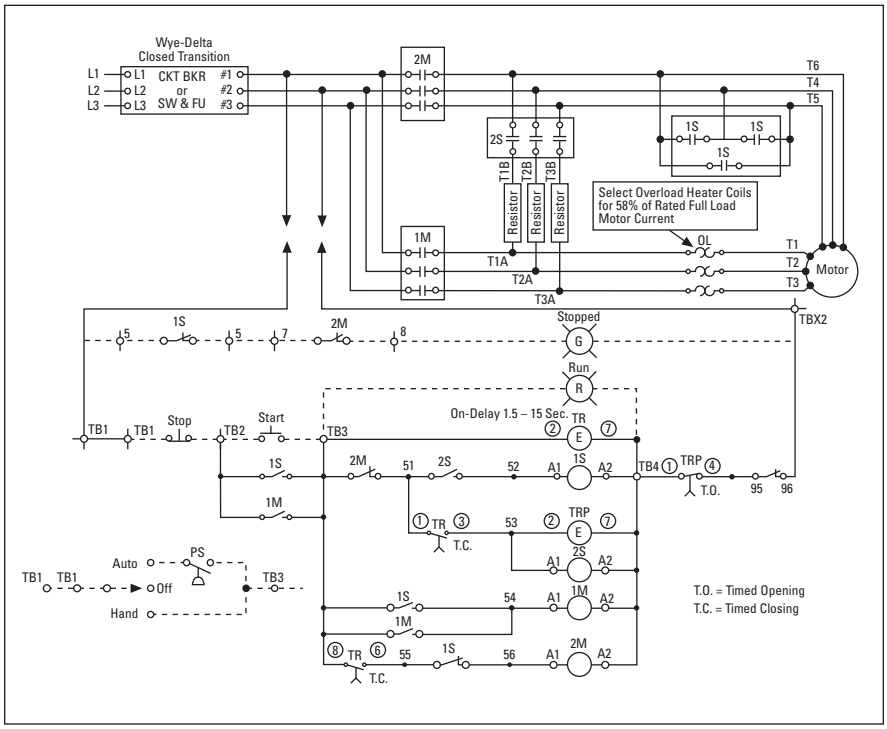

Figure 31.5-6. Typical Schematic Diagram

Table 31.5-9. Type 1, 3R, 4/4X, 12 Freedom Reduced Voltage Enclosures

Size	Type 1		Type 3R, 4X, 12	
	Box No.	Shipping Wt. Lbs. (kg)	Box No.	Shipping Wt. Lbs. (kg)
Classes 48 & 51: Wye Delta — Non-combination **Classes 49 & 52: Wye Delta — with Disconnect** **Classes 50 & 53: Wye Delta — with Thermal Magnetic Trip Circuit Breaker**				
2YD – 4YD	E	185 (84)	E	225 (102)
5YD	F1E	605 (275)	F1E	705 (320)
6YD ②	F1E	635 (288)	F1E	735 (334)
6YD ③	F2E	715 (325)	F2E	830 (377)
7YD	F2E	④	F2E	④
8YD	F2E	④	F2E	④

② Non-combination and breaker.
③ Fusible.
④ Consult factory.

For enclosure box dimensions, refer to Page 31.7-3.

IT. Enclosed Reduced Voltage Starters

IT. Enclosed Reduced Voltage Starters

Product Description

Eaton offers a complete line of solid-state reduced voltage devices ranging from fractional horsepower applications to 1000 ampere devices. The line comes in voltages from 200 to 600 Vac and operates on 50 or 60 Hz applications. Units can be ordered as open components or mounted in enclosures (NEMA 1, 3R, 4X and 12). Motor Control Center (MCC) mounting is also possible with units through 700 hp fitting inside of a standard MCC.

Available in three different product classes, these soft start devices provide reduced voltage starting of ac induction motors. Motor voltage is controlled by means of back-to-back SCRs (silicon controlled rectifiers) providing a smooth, stepless start (and stop) of the motor driven load.

For more information, please visit the Eaton Web site at **www.EatonElectrical.com**.

TL — Torque Limiter

Designed for the soft start of 3-phase or single-phase motors, i.e., it allows smoother starting of all ac induction motors, thus decreasing shock and vibration problems encountered during across-the-line starts. Unit is installed between an existing electromechanical starter or Manual Motor Starter and the motor. No overload protection is included with the device. Available up to 25 amperes continuous duty.

S701 — Soft Start Controllers

Designed to control acceleration and deceleration of 3-phase motors. The S701 provides the user with the ability to adjust initial torque, ramp up and down time and also select "kick start" for high inertial loads. Unit is installed between an existing electromechanical starter or Manual Motor Starter and the motor. No overload protection is included with the device. Available up to 25 amperes continuous duty.

S752 — Soft Starters

Eaton's revolutionary design for soft starters is shown in the S752 soft starter products which are members of the Cutler-Hammer Intelligent Technologies (***IT.***) family of products. These Reduced Voltage Soft Starters are the most compact, multi-functional, easy-to-install products on the market. Their superiority begins with the control package, which features 24 Vdc control, onboard Digital Signal Processor (DSP), and use of a low impedance run contactor, all of which contribute to the ***IT.*** Soft Starter's safety, advanced functionality and compact size.

Designed to control acceleration and deceleration of three-phase motors, products are available from .25 to 50 amps and are suitable for mounting in a variety of enclosures including Type 1, 12, 3R, 4, 4X and 7/9.

S801 — Soft Starters

The Intelligent Technologies (***IT.***) line of soft starters combines the power control, overload and bypass function in one very compact, multifunctional, easy-to-install and easy-to-program soft starter. Designed to control acceleration and deceleration of 3-phase motors, the line is available for current ranges from 1 ampere all the way through 1000 ampere applications. A full feature starter with built-in overload (Trip Class 5, 10, 20 or 30) adjustable from 30 – 100%, multiple protective features and a built-in bypass contactor. It is ideal for new installations and for retrofitting existing across-the-line starters in existing structures.

S811 — Soft Starters

Eaton's revolutionary design for soft starters is shown in the S811 soft starter products which are members of the Cutler-Hammer Intelligent Technologies (***IT.***) family of products. These Reduced Voltage Soft Starters are the most compact, multi-functional, easy-to-install products on the market. Their superiority begins with the control package, which features 24 Vdc control, onboard digital Signal Processor (DSP), and use of a low impedance run contactor, all of which contribute to the ***IT.*** Soft Starter's safety, advanced functionality and compact size.

Designed to control acceleration and deceleration of three-phase motors, products are available from 37 to 1000 amps and are suitable for mounting in a variety of enclosures including Type 1, 12, 3R, 4, 4X and 7/9.

Applications

The Cutler-Hammer soft start product line can be applied in a wide array of customer applications. Typical benefits of soft starters include:

- Reduced starting torque stress on mechanical equipment, allowing longer life of belts, gears, pulleys and motor shafts commonly weakened during "across-the-line" starting.
- Reduction of voltage drop during starting on weak utility systems where the performance of nearby equipment would be negatively affected.
- Reduced inrush current during starting which can result in lower utility bills due to the reduction in peak current demand charges.
- Smooth, stepless starting of a motor, allowing superior flexibility over typical electromechanical starting methods.
- Ability to start large loads on backup generators during power outages.
- Elimination of the water-hammer effect in hydraulic systems, which can help to eliminate additional pipe hangers and extend the life of the system, pumps, valves and gaskets.

Typical Applications Include:

- Centrifugal and screw compressors.
- Material handling equipment.
- Fans and blowers.
- Pumps.
- Cranes and hoists.
- Food processing.
- Machinery.
- Rock crushers.
- HVAC industry.

Enclosure Type

Airborne particulate may be detrimental to starter performance and reliability, so caution must be exercised in choosing the enclosure best suited to the environment. The NEMA rating of the enclosure defines its ability to withstand the ingress of foreign particulate as described below:

NEMA 1

A general purpose, indoor-type enclosure.

NEMA 12

A dust-tight and drip-tight enclosure for indoor industrial applications.

NEMA 3R

Enclosures are intended for outdoor use, primarily to provide a degree of protection against falling rain, sleet and external ice formation.

NEMA 4

A watertight and dust-tight enclosure for either indoor or outdoor use.

NEMA 4X

Identical to NEMA 4, with the additional requirement that the enclosure be corrosion-proof as well.

NEMA 7/9

Enclosures capable of preventing the entrance of dust and withstanding pressure resulting from an internal explosion of specified gas.

Catalog Number Selection

Table 31.6-1. Solid-State Enclosed Control Catalog Numbering System

EC S 90 S 1 C A A

Type
S = Solid-State

Class
90 = Non-combination S752/S801 ***IT***. Soft Start
91 = Combination S752/S801 ***IT***. Soft Start with Fusible Disconnect
92 = Combination S752/S801 ***IT***. Soft Start with HMCP
93 = Non-combination S811 ***IT***. Soft Start with DIM
94 = Combination S811 ***IT***. Soft Start with Fusible Disconnect and DIM
95 = Combination S811 ***IT***. Soft Start with HMCP and DIM

Amperes			
S752	**S801/S811**		
J = .8	**Q** = 37	**Z** = 240	**5** = 650
K = 1.9	**S** = 66	**1** = 304	**6** = 720
L = 4.4	**V** = 105	**2** = 360	**7** = 850
M = 9	**W** = 135	**3** = 420	**8** = 1000
N = 16	**Y** = 180	**4** = 500	
P = 27			
R = 50			

Enclosure Type
1 = Type 1
2 = Type 3R
3 = Type 4
4 = Type 4X (304-Grade SS)
6 = Type 7/9
8 = Type 12
9 = Type 4X (316-Grade SS)

Cover Control
See **Page 31.7-3** for Options

Voltage	
B = 230 V	**E** = 200 V
C = 460 V	**Q** = 24 Vdc
D = 575 V	

Disconnect Fuse Clip Ratings		
A = None	**G** = 100 A/600 V R	**N** = 600 A/600 V R
B = 30 A/250 V R	**H** = 200 A/250 V R	**P** = 800 A/600 V L
C = 30 A/600 V R	**J** = 200 A/600 V R	**Q** = 1200 A/600 V L
D = 60 A/250 V R	**K** = 400 A/250 V R	**R** = 1600 A/600 V L
E = 60 A/600 V R	**L** = 400 A/600 V R	**S** = 2000 A/600 V L
F = 100 A/250 V R	**M** = 600 A/250 V R	**T** = by Description

Breaker		
A = None	**F** = 50 A	**K** = 400 A
B = 3 A	**W** = 70 A	**L** = 600 A
C = 7 A	**G** = 100 A	**P** = 1200 A
D = 15 A	**H** = 150 A	**Q** = 1600 A
E = 30 A	**J** = 250 A	

Table 31.6-2. Solid-State Product Comparison

Description	TL — Torque Limiter	S701 — Soft Start Controller	S752 — Soft Starter	S801 — Soft Starter	S811 — Communicating Soft Starter
Maximum Current Range	0 – 25 Amperes	0 – 25 Amperes	①	1 – 1000 Amperes	1 – 1000 Amperes
Start Type	Ramp	Ramp	Ramp	Ramp or Current Limit	Ramp or Current Limit
Operating Voltage	200 – 600 Vac	200 – 600 Vac	200 – 600 Vac	200 – 600 Vac	200 – 600 Vac
Operating Frequency	50/60 Hz	50/60 Hz	47 – 63 Hz	47 – 63 Hz	47 – 63 Hz
Control Voltage	None Required	24 – 300 Vac/dc	24 Vdc	24 Vdc	24 Vdc
Kick Start	No	Fixed	No	0 – 2 Seconds Adjustable	0 – 2 Seconds Adjustable
Ramp Time Range	.5 – 5 Seconds	.5 – 10 Seconds	.5 – 30 Seconds	.5 – 180 Seconds	.5 – 180 Seconds
Initial Torque Setting	0% – 85%	0% – 85%	0% – 95%	0% – 85%	0% – 85%
Current Limit Setting	N/A	N/A	N/A	0% – 550%	0% – 550%
Soft Stop	No	0 – 10 Seconds	0 – 30 Seconds	0 – 60 Seconds	0 – 60 Seconds
Pump Control Option	No	No	No	Yes	Yes
Overtemperature Protection	Optional	Optional	Yes	Yes	Yes
Overload	No	No	Yes	Yes	Yes
Overload Setting	N/A	N/A	31% – 100%	30% – 100%	30% – 100%
Trip Class Setting	N/A	N/A	10, 20 and 30	5, 10, 20 and 30	5, 10, 20 and 30
Phase Loss/Unbalance	N/A	N/A	Yes	Yes	Yes
Jam	N/A	N/A	No	Yes	Yes
Stall	N/A	N/A	No	Yes	Yes
Phase Reversal	N/A	N/A	Indication Only	Yes	Yes
Jog	No	No	No	Yes	Yes
Extended Start	No	No	No	Yes	Yes
LED Status Indication	Yes	Yes	Yes	Yes	LCD — Yes
LED Fault Indication	No	No	Yes	Yes	LCD — Yes

① In-line: 0.25 – 50 amperes. Inside-the-delta: 0.44 – 78 amperes.

Table 31.6-3. Application and Environmental Considerations

The installation environment for a solid-state reduced voltage starter is of a prime concern. Conditions such as ambient temperature, altitude and the presence of corrosives or moisture must all be considered when choosing the appropriate starter size and enclosure type.

Description	TL — Torque Limiter	S701 — Soft Start Controller	S752 — Soft Starter	S801 — Soft Starter	S811 — Communicating Soft Starter
Temperature — Operating	-5°C – 40°C	-5°C – 40°C	-35°C – 50°C	-25°C – 40°C	-30°C – 50°C
(No Derating)					
Current Rating (50°C)	80%	80%	100%	100%	100%
Limited Duty Cycle (50°C)	15-Minute Duty Cycle (maximum 8)	16-Minute Duty Cycle (maximum 8)	Fully Rated	Fully Rated	Fully Rated
Current Rating (60°C)	65%	65%	10% Reduction	10% Reduction	Consult Factory
Limited Duty Cycle (60°C)	16-Minute Duty Cycle (maximum 65)	16-Minute Duty Cycle (maximum 65)	Consult Factory	Continuous Duty Cycle at 90%	Consult Factory
Temperature — Storage	-5°C – 40°C	-5°C – 40°C	-40°C – 80°C	-40°C – 70°C	-50°C – 70°C
Altitude (meters)	2000	2000	2000	2000	2000

Note: Consult factory for applications outside of these parameters for additional information and sizing requirements.

Multi-Motor Operation

The S801/S811 line can be used to control multiple motors if the following conditions are met:

- The current rating of the S801/S811 should be equal to or greater than the total of the individual motor full load amperes and the S801/S811 overload must be set for the cumulative full load amperes of the motors.
- Individual motor overcurrent protection is provided by other devices.
- The motors should not be mechanically coupled together, i.e., two motors on same shaft.
- NEC and local code requirements for individual motor protection and branch short circuit protection are met.
- Motors are closely matched in total load and size.

Frequent Starting/Stopping

The number of starts and stops allowable depends upon many factors. The most important ones are:

1. Set level of the starting current limit.
2. Start time.
3. Run time.
4. Off time before next start.

The number of starts per hour is based on the current carrying capacity of the SCRs. A high start/stop duty may require the oversizing of a soft starter. If a high number of multiple starts occur, the starter may trip due to the overload protection for the motor or it may trip on overtemperature of the soft starter. In this situation, it is advisable to wait a period of 10 minutes before restarting to avoid damage to the soft starter and motor and allow the units to cool down. The motor manufacturer should be consulted about the effect of a high number of multiple starts on motor life.

Starting Torque

The reduced voltage applied to the motor results in reduced inrush current and a soft start. However, it reduces the starting torque of the motor. The relationship is as follows:

$$\frac{\text{Torque at reduced current}}{\text{Torque at full current}} = \frac{\text{Current at reduced voltage}^2}{\text{Current at full voltage}}$$

EXAMPLE: A 100 hp, 1800 RPM, 460 V NEMA B motor draws six times full load amperes for starting, and starting torque is 150% of full load torque.

If the same motor were started with the S801 at 300% current limit, then the available torque would be:

$$\frac{300^2}{600} = \frac{90{,}000}{360{,}000} =$$

1/4 x 150% full load torque =

37.5% full load torque available

Heat Generation

Due to the voltage drop that occurs across a SCR, there is heat generated in the unit. For sizing an enclosure or box size for the soft starters, it is important to account for this heat generation.

With the Torque Limiter, the heat generation is equivalent to 1 watt per ampere of full load current. For the S701 line, the heat generation is equivalent to two watts per ampere of full load current. The S752/S801/S811 lines use a bypass contactor so its heat generation is a little more complex. During steady state conditions, it generates about the same amount of heat as an across-the-line starter of the same size. During start and stopping ramps it will generate three watts of heat per ampere.

EXAMPLE: A 100 hp, 480 V NEMA B motor has a full load current of 125 amperes. A typical soft start on this motor is 300% current limit for 40 seconds. The heat generation during this time period is:

125 amperes x 300% =
375 watts for 40 seconds

At the end of the ramp, the bypass contactor closes and total heat generation is reduced to much lower levels.

NEMA Design C and D Motors, Wound Rotor Motors

These motors are used due to their high starting torque characteristics. When high starting currents and high starting torques are required, it may be necessary to order the extended ramp option and oversize the soft starter to match the application requirements. Consult the factory for application considerations.

Solid-State Reduced Voltage Starters

Enclosed Box Selection

Table 31.6-4. Non-combination Solid-State Reduced Voltage Box Dimensions

Ampere Rating	SSRV	Non-combination Box No. ①
.8 – 27	S752	6A ②
37	S801/S811	7A
50	S752	6A ②
66	S801/S811	7A
105	S801/S811	7A
135	S801/S811	B1
180	S801/S811	C
240	S801/S811	G1
304	S801/S811	G1
360	S801/S811	G1
420	S801/S811	10
500	S801/S811	10
650	S801/S811	10
720	S801/S811	10
850	S801/S811	10
1000	S801/S811	10

① Enclosure space will also accommodate for an ***IT.*** Power Supply, two 4-pole relays, CPT, and terminal blocks. Also includes space for a DNA module or MOV.

② Same as footnote ①, but CPT is not included. Upsize to 7A enclosure to include space for a CPT and a full voltage bypass contactor.

Note: All Type 7 and 9, see **Section 11**.

Table 31.6-5. Combination Solid-State Reduced Voltage Box Dimensions

Ampere Rating	SSRV	Comb. with Fuses Box No. ③	Comb. with HMCP Box No. ③
.8 – 27	S752	B1 ④	A1 ⑤
37	S801/S811	B1	A1 ⑤
50	S752	C	A1 ⑤
66	S801/S811	C	A1
105	S801/S811	D	B1
135	S801/S811	D	C
180	S801/S811	E	E
240	S801/S811	F1E	E
304	S801/S811	F1E	E
360	S801/S811	F1E	E
420	S801/S811	F1E	E
500	S801/S811	F1E	E
650	S801/S811	F1E	F1E
720	S801/S811	F1E	F1E
850	S801/S811	F1E	F1E
1000	S801/S811	F1E	F1E

③ Enclosure space will also accommodate for an ***IT.*** Power Supply, two 4-pole relays, CPT, and terminal blocks. Also includes space for a DNA module or MOV.

④ Enclosure may be reduced to an A1, with all space for all items as in footnote ③, excluding relays and CPTs.

⑤ Same as footnote ③, but CPT is not included. Upsize to B1 enclosure to include space for a CPT and a full voltage bypass contactor.

Note: For enclosure box dimensions, refer to **Page 31.7-3**.

S752 Open Soft Starters

S752

Product Description

Eaton's Cutler-Hammer Intelligent Technologies (***IT.***) S752 Line of Reduced Voltage Soft Starters is very compact, multi-functional, easy to install and easy to program. Designed to control the acceleration and deceleration of three-phase motors, the device is available in configurations to be applied either in the line of the motor, or in the delta windings of the motor. The in-line device is available for current ranges from 0.25 to 50 amps. The inside-the-delta device is available for current ranges from 0.44 to 78 amps.

The S752 is a redesign of the popular S751 soft starter. Design enhancements include an increased current rating, short circuit coordination ratings with breakers and fuses, and inside-the-delta control. The S752 has replaced the S751 in the Cutler-Hammer product offering.

The S752 is designed to be a complete package combining the SCRs, bypass contactor and overload in one, very compact device. The S752 is available as a component for panel mounting, in Motor Control Centers or in Enclosed Control (NEMA Type 1, 3R, 4, 4X, 7/9 and 12).

Application Description

The S752 combines the soft starter overload, bypass contactor into one device for fast and easy installation. With its small size, it can easily fit in place of existing soft starters, wye-delta starters or across-the-line NEMA and IEC starters. This feature allows easy upgrades to existing systems.

The in-line version is designed for use with three-phase motors in a delta (three-lead) configuration. The product is designed to be wired in the three-phase line feeding the three motor input leads as is done for normal across-the-line starting.

The inside-the-delta version is to be used on 6-lead or 12-lead wye-delta motors. The device is wired into the windings of the motor. A reduced voltage start is achieved without the need to reconnect the motor in wye and delta configurations. The S752 offers enhanced performance over traditional wye-delta electromechanical starters.

The starter uses Silicon Controlled Rectifiers (SCRs) to ramp the voltage to the motor, providing smooth acceleration and deceleration of the load. After the motor is started, the internal run bypass contactor closes, resulting in the motor running directly across-the-line. Internal run bypass significantly reduces the heat generated as compared to non-bypass starters. The soft stop option allows for a ramp stop time that is longer than the coast-to-stop time.

The built-in solid-state overload protects the motor from overload conditions with sophisticated algorithms that model true motor heating, resulting in better motor protection and fewer nuisance trips. Advanced protective and diagnostic features reduce downtime.

The S752 was designed with safety in mind. The device features a fully motor-rated run bypass contactor. The bypass contactor is capable of breaking the motor load in failed SCR conditions. Short circuit protection ratings are offered with both circuit breakers and fuses. Safety is enhanced with the use of green materials, 24 Vdc control and finger safe IP20 terminals.

Features and Benefits

- Run bypass significantly reduces the heat generated as compared to non-bypass soft starters. Less heat minimizes enclosure size and cooling requirements and maximizes the life of all devices in the enclosure.
- Run bypass mode greatly reduces internal heating created by the power dissipation across the SCRs. The bypass contactor directly connects the motor to the line and improves system efficiency by reducing internal power losses.
- Solid-state overload protection provides accurate current measurement and trip settings. Sophisticated algorithms solve a series of differential equations that model true motor heating and cooling, resulting in superior motor overload protection while minimizing nuisance trips. Advanced selectable protective features safeguard the motor and system against a variety of system faults.
- Six SCRs control all three motor phases providing smooth acceleration and deceleration performance.
- Easy to read LED displays device status and provides fault indication.
- Internal run bypass contactors and overload protection eliminate the need for additional devices, thereby reducing enclosure sizes, minimizing installation and wiring time and reducing overall assembly size and cost.
- Variable ramp times and torque control settings provide unlimited starting configurations, allowing for maximum application flexibility.
- Soft stop control suits applications where an abrupt stop of the load is not acceptable.

- Wide range of overload FLA settings (31 – 100% of rated current) and selectable trip class (10, 20, 30) allows for wide application range while offering users the flexibility to fine tune the starter to match their specific application requirements.
- Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings.
- Minimizes the peak inrush current's stress on the power system.
- Minimizes peak starting torque to diminish mechanical system wear and damage.
- 24 Vdc control module enhances personnel and equipment safety.
- Removable, lockable control terminal block reduces maintenance replacement costs. Also provides the opportunity for OEMs to reduce assembly and test costs by utilizing pre-assembled wire harnesses.

Protective Features

Motor Overload

The S752 includes electronic overload protection as standard. The overload meets applicable requirements for a motor overload protective device. The overload protects the motor from over heat conditions with the use of sophisticated algorithms that model true motor heating resulting in superior motor protection and fewer nuisance trips.

The S752 calculates a thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur removing power to the motor. Upon trip, the S752 stores the calculated motor heating value and will not allow a motor re-start until the motor has sufficiently cooled. This feature ensures the motor will not be damaged by repeated overload trip and re-start cycles.

The trip current is adjusted to match the specific application requirements by adjusting the overload FLA setting. The FLA adjustment includes a 3 to 1 adjustment range. The overload trip class is selectable for class 10, 20 and 30. The overload is ambient temperature compensated, meaning its trip characteristics will not vary with changes in ambient temperature.

Short Circuit

The use of a short circuit protective device in coordination with the S752 is required in branch motor circuits by most electrical codes. Short circuit coordination ratings with both Cutler-Hammer molded case circuit breakers and fuses are available providing customers with design flexibility. The S752 has short circuit coordination ratings as an open component, an enclosed starter, and in a Motor Control Center.

Pole Over Temperature

High ambient temperatures, extended ramp times and high duty cycle conditions may cause the S752 power pole conductors to reach a temperature that exceeds their thermal rating. The S752 is equipped with sensors that monitor the temperature of the power poles. Over temperature protection exists if the device's thermal capacity is exceeded. The soft starter will trip in over temperature conditions, preventing device failure.

Phase Loss

Loss of a phase can cause a significant increase in current drawn in the remaining two phases. Phase loss can lead to motor damage before an eventual overload trip occurs. Phase loss is typically an indication of a failure in the electrical distribution system. The S752 can detect a phase loss and after 10 seconds a phase loss trip will occur. The phase loss protection can be enabled or disabled.

Phase Imbalance

Phase current or voltage imbalance can cause a significant increase in the current drawn in the other phases. Phase imbalance can lead to motor damage before an eventual overload trip. Phase loss is typically an indication of a failure in the electrical distribution system or the motor. A phase current imbalance trip will occur if one or two of the line currents are 50% or less of the remaining line(s) for longer than 10 seconds. The phase imbalance protection can be enabled or disabled.

Reset Mode

The S752 can be set up for automatic or manual reset on trip. The manual reset mode requires the operator to physically press the RESET button located on the soft starter. The automatic reset mode allows the soft starter to be automatically reset as soon as the trip condition is no longer present. With the automatic reset mode, after the fault is no longer present, the motor will be restarted as soon as a valid start signal is present. The overload can be reset through the communications network. The overload can also be electrically reset by energizing a 24 Vdc control input on the control terminal block.

Bypass Dropout

The S752 can detect if the bypass contactor fails to close after the ramp start or opens while the motor is running. The S752 will trip on a bypass dropout fault if either of these conditions occur.

Diagnostic Features

The S752 has an easy to read LED that displays the device status as well as identifying the condition that caused a fault. The fault display is a useful tool in system troubleshooting. The following fault cross-reference is listed on the overload cover of the device to facilitate fault identification:

Table 31.6-6. S752 Diagnostic Features

LED Display Code	Device Status or Fault
0	Ready To Start
1	Line Phase Reversal
2	Phase Loss Fault
3	Phase Imbalance Fault
4	SCR Over Temperature Fault
5	Overload Trip Fault
6	Test Trip Fault
7	Bypass Dropout Fault
8	Overload Communications Fault
9	Temperature Sensor Fault

Communication Capabilities

Communications are enabled with the S752 soft starter with the addition of a SNAP (Starter Network Adapter Product). The SNAP allows for network control and monitoring of system parameters. See Tab 50 of publication CA08102001E for more information on SNAPs.

Operation

Voltage Ramp Start

Provides a voltage ramp to the motor resulting in a constant torque increase. The most commonly used form of soft start, this start mode allows you to set the initial torque value and the duration of the ramp to full voltage conditions. Bypass contactor(s) close after ramp time.

- Adjustable initial torque 0 – 95% of locked rotor torque.
- Adjustable ramp time .5 – 30 seconds.

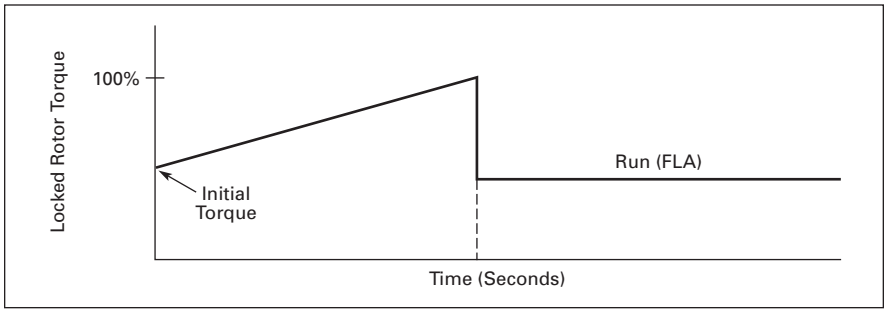

Figure 31.6-1. Starting Characteristics — Ramp Start

Soft Stop

Allows for a controlled stopping of a load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or product damage.

- Stop time = 0 – 30 seconds.

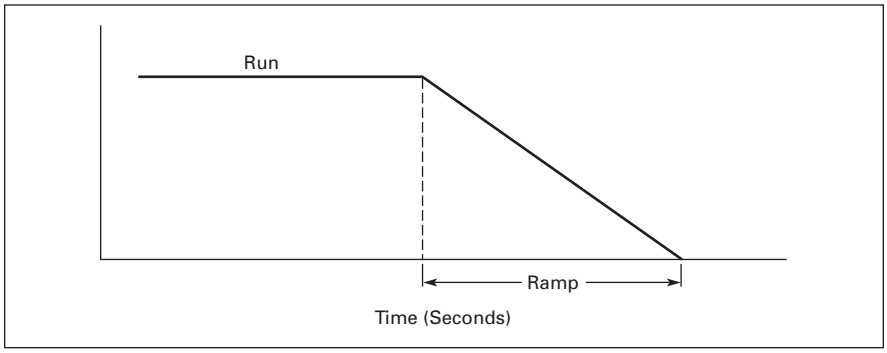

Figure 31.6-2. Starting Characteristics — Soft Stop

Catalog Number Selection

Table 31.6-7. S752 Open Soft Starters Catalog Numbering System

S 752 L 50 N 3 S

S = ***IT.*** Soft Starter

752 = Non-combination Soft Starter

Frame Size
L = 54 mm

Device Rating

01 = 1 Amp	**16** = 16 Amp
02 = 2 Amp	**27** = 27 Amp
04 = 4 Amp	**50** = 50 Amp
09 = 9 Amp	

N = No Options

3 = 3-Pole Device

S = Standard Soft Starter — In-Line Control
D = Inside-the-Delta Control

Voltage Rating ①
V02 = 240 V
V06 = 600 V

① Inside-the-delta version only.

Product Selection

IT. S752 Product Selection — In-Line

Standard Duty Ratings

Standard duty ratings are defined as those that do not exceed any of the following operating conditions:

- 25 second ramp, 2 starts per hour, 40°C ambient, 300% FLA current
- 15 second ramp, 4 starts per hour, 40°C ambient, 300% FLA current
- 10 second ramp, 6 starts per hour, 40°C ambient, 300% FLA current
- 7.5 second ramp, 8 starts per hour, 40°C ambient, 300% FLA current
- 3.0 second ramp, 15 starts per hour, 40°C ambient, 300% FLA current

Table 31.6-8. *IT.* S752 Soft Starter Standard Duty Ratings ① — In-Line

Maximum Continuous Current	FLA Current Range	kW Rating (50 Hz)			Horsepower Rating (60 Hz)				Catalog Number
		230 V	380 – 400 V	440 V	200 V	230 V	460 V	575 V	
0.8	0.25 – 0.8	0.3	0.37	0.55	1/8	1/6	1/3	1/3	**S752L01N3S**
1.9	0.59 – 1.9	0.6	1.1	1.1	1/3	1/3	3/4	1	**S752L02N3S**
4.4	1.4 – 4.4	1.5	2.2	3	3/4	1	2	3	**S752L04N3S**
9	2.8 – 9.0	3	5.5	5.5	2	2	5	7-1/2	**S752L09N3S**
16	5.0 – 16	5.5	10	11	3	5	10	10	**S752L16N3S**
27	8.4 – 27	10	15	18.5	7-1/2	7-1/2	20	25	**S752L27N3S**
50	16 – 50	12.5	22	30	10	15	30	40	**S752L50N3S**

① For applications above 40°C, derate 1% per °C.

Heavy Duty Ratings

Heavy duty ratings are defined as those that do exceed any of the following operating conditions:

- 25 second ramp, 2 starts per hour, 40°C ambient, 400% FLA current
- 15 second ramp, 4 starts per hour, 40°C ambient, 400% FLA current
- 10 second ramp, 6 starts per hour, 40°C ambient, 400% FLA current
- 7.5 second ramp, 8 starts per hour, 40°C ambient, 400% FLA current
- 3.0 second ramp, 15 starts per hour, 40°C ambient, 400% FLA current

Table 31.6-9. *IT.* S752 Soft Starter Heavy Duty Ratings ② — In-Line

Maximum Continuous Current	FLA Current Range	kW Rating (50 Hz)			Horsepower Rating (60 Hz)				Catalog Number
		230 V	380 – 400 V	440 V	200 V	230 V	460 V	575 V	
0.8	0.25 – 0.8	0.3	0.37	0.55	1/8	1/6	1/3	1/3	**S752L01N3S**
1.9	0.59 – 1.9	0.6	1.1	1.1	1/3	1/3	3/4	1	**S752L02N3S**
4.4	1.4 – 4.4	1.5	2.2	3	3/4	1	2	3	**S752L04N3S**
9	2.8 – 9.0	3	5.5	5.5	2	2	5	7-1/2	**S752L09N3S**
16	5.0 – 16	5.5	10	11	3	5	10	10	**S752L16N3S**
27	8.4 – 27	10	15	18.5	5	7-1/2	15	20	**S752L27N3S**
50	16 – 50	12.5	15	20	7-1/2	10	20	25	**S752L50N3S**

② For applications above 40°C, derate 1% per °C.

Severe Duty Ratings

Severe Duty ratings are defined as those that do exceed any of the Heavy Duty operating conditions. Please contact the Technical Resource Center for Severe Duty application assistance.

IT. S752 Product Selection — Inside-the-Delta

Standard Duty Ratings

Standard duty ratings are defined as those that do not exceed any of the following operating conditions:

- 10 second ramp, 6 starts per hour, 40°C ambient, 300% FLA current
- 7.5 second ramp, 8 starts per hour, 40°C ambient, 300% FLA current
- 3.0 second ramp, 15 starts per hour, 40°C ambient, 300% FLA current

Table 31.6-10. *IT.* S752 Soft Starter Standard Duty Ratings ① — Inside-the-Delta

Maximum Continuous Current	FLA Current Range	kW Rating (50 Hz)			Horsepower Rating (60 Hz)				Catalog Number ②
		230 V	380 – 400 V	440 V	200 V	230 V	460 V	575 V	
1.3	0.44 – 1.3	0.18	0.37	0.55	1/4	1/3	1/2	3/4	**S752L01N3D_ _ _**
3.2	1.1 – 3.2	0.55	1.1	1.5	1/2	3/4	1-1/2	2	**S752L02N3D_ _ _**
7.6	2.5 – 7.6	1.5	3	4	1-1/2	1-1/2	3	5	**S752L04N3D_ _ _**
15	4.9 – 15	3.7	6.5	8	3	3	7-1/2	10	**S752L09N3D_ _ _**
27	8.7 – 27	6.5	12.5	15	7-1/2	7-1/2	15	25	**S752L16N3D_ _ _**
46	15 – 46	12.5	22	25	10	15	30	40	**S752L27N3D_ _ _**
78	28 – 86	22	37	45	25	25	60	75	**S752L50N3D_ _ _**

① For applications above 40°C, derate 1% per °C.
② For Voltage Suffix, See **Table 31.6-11**.

Table 31.6-11. Voltage Suffix Code

Voltage Suffix	Voltage
V02	< 240 V
V06	250 – 600 V

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Heavy Duty Ratings

Heavy duty ratings are defined as those that do not exceed any of the following operating conditions:

- 10 second ramp, 6 starts per hour, 40°C ambient, 400% FLA current
- 7.5 second ramp, 8 starts per hour, 40°C ambient, 400% FLA current
- 3.0 second ramp, 15 starts per hour, 40°C ambient, 400% FLA current

Table 31.6-12. *IT.* S752 Soft Starter Light Duty Ratings ③ — Inside-the-Delta

Maximum Continuous Current	FLA Current Range	kW Rating (50 Hz)			Horsepower Rating (60 Hz)				Catalog Number ④
		230 V	380 – 400 V	440 V	200 V	230 V	460 V	575 V	
1.3	0.44 – 1.3	0.18	0.37	0.55	1/4	1/3	1/2	3/4	**S752L01N3D_ _ _**
3.2	1.1 – 3.2	0.55	1.1	1.5	1/2	3/4	1-1/2	2	**S752L02N3D_ _ _**
7.6	2.5 – 7.6	1.5	3	4	1-1/2	1-1/2	3	5	**S752L04N3D_ _ _**
15	4.9 – 15	3.7	6.5	8	3	3	7-1/2	10	**S752L09N3D_ _ _**
27	8.7 – 27	6.5	12.5	15	7-1/2	7-1/2	15	25	**S752L16N3D_ _ _**
46	15 – 46	12.5	22	25	10	15	30	40	**S752L27N3D_ _ _**
78	28 – 86	15	25	30	15	20	40	60	**S752L50N3D_ _ _**

③ For applications above 40°C, derate 1% per °C.
④ For Voltage Suffix, See **Table 31.6-13**.

Table 31.6-13. Voltage Suffix Code

Voltage Suffix	Voltage
V02	< 240 V
V06	250 – 600 V

Severe Duty Ratings

Severe Duty ratings are defined as those that do exceed any of the Heavy Duty operating conditions. Please contact the Technical Resource Center for Severe Duty application assistance.

Technical Data

Table 31.6-14. S752 Open Soft Starters

Soft Starter (Partial Catalog Number)	S752 L01	S752 L02	S752 L04	S752 L09	S752 L16	S752 L27	S752 L50
In-Line Current Capacity	0.8	1.9	4.4	9.0	16	27	50
Inside-the-Delta Current Capacity	1.3	3.2	7.6	15	27	46	78
Dimensions							
Width in Inches (mm)	2.14 (54)	2.14 (54)	2.14 (54)	2.14 (54)	2.14 (54)	2.14 (54)	2.14 (54)
Height in Inches (mm)	7.78 (198)	7.78 (198)	7.78 (198)	7.78 (198)	7.78 (198)	7.78 (198)	7.78 (198)
Depth in Inches (mm)	5.13 (130)	5.13 (130)	5.13 (130)	5.13 (130)	5.13 (130)	5.13 (130)	5.13 (130)
Weight in lbs. (kg)	3.5 (1.6)	3.5 (1.6)	3.5 (1.6)	3.5 (1.6)	3.5 (1.6)	3.5 (1.6)	3.5 (1.6)
Electrical Characteristics							
Line Voltage (Vac)	200 – 600	200 – 600	200 – 600	200 – 600	200 – 600	200 – 600	200 – 600
Operating Frequency (Hz)	47 – 63	47 – 63	47 – 63	47 – 63	47 – 63	47 – 63	47 – 63
Leakage Current	15 mA ac max.						
Min. Operating Current	100 mA						
Control Voltage (24 Vdc ±10%)	21.6 – 26.4	21.6 – 26.4	21.6 – 26.4	21.6 – 26.4	21.6 – 26.4	21.6 – 26.4	21.6 – 26.4
Response Time Max.	100 mS	100 mS	100 mS	100 mS	100 mS	100 mS	100 mS
Control Steady State Current	200 mA	200 mA	200 mA	200 mA	200 mA	200 mA	200 mA
Inrush Current (During Bypass)	3.6A @ 50 mS	3.6A @ 50 mS	3.6A @ 50 mS	3.6A @ 50 mS	3.6A @ 50 mS	3.6A @ 50 mS	3.6A @ 50 mS
Control Wiring							
(+ and -) 1 Wire per Terminal	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)	14 – 12 AWG (1.5 – 2.5 mm^2)
(+ and -) 2 Wires per Terminal	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)	14 AWG (1.5 mm^2)
(P,F,1,2,3) 1 Wire per Terminal	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)	22 – 12 AWG (0.5 – 2.5 mm^2)
(P,F,1,2,3) 2 Wires per Terminal	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)	18 – 14 AWG (0.75 – 1.5 mm^2)
Torque (max.)	4.5 lb-in (0.5 Nm)	4.5 lb-in (0.5 Nm)	4.5 lb-in (0.5 Nm)	4.5 lb-in (0.5 Nm)	4.5 lb-in (0.5 Nm)	4.5 lb-in (0.5 Nm)	4.5 lb-in (0.5 Nm)
Driver	0.13 (3.5 mm) Flat	0.13 (3.5 mm) Flat	0.13 (3.5 mm) Flat	0.13 (3.5 mm) Flat	0.13 (3.5 mm) Flat	0.13 (3.5 mm) Flat	0.13 (3.5 mm) Flat
Terminals L1, L2, L3/T1, T2, T3 — Use Class B 75°C copper wire only							
1 Wire per Terminal	14 – 4 AWG (1.5 – 16 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)	14 – 4 AWG (1.5 – 16 mm^2)
2 Wires per Terminal	14 – 6 AWG (1.5 – 12 mm^2)	14 – 6 AWG (1.5 – 12 mm^2)	14 – 6 AWG (1.5 – 12 mm^2)	14 – 6 AWG (1.5 – 12 mm^2)	14 – 6 AWG (1.5 – 12 mm^2)	14 – 6 AWG (1.5 – 12 mm^2)	14 – 6 AWG (1.5 – 12 mm^2)
Torque (max.) 14 – 10 AWG (1.5 – 6 mm^2) 8 AWG (10 mm^2) 6 – 4 AWG (6 – 4 mm^2)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)	35 lb-in (4 Nm) 40 lb-in (4.5 Nm) 45 lb-in (5 Nm)
Connector Type	Box Lug	Box Lug	Box Lug	Box Lug	Box Lug	Box Lug	Box Lug
Driver	3mm Hex Key	3mm Hex Key	3mm Hex Key	3mm Hex Key	3mm Hex Key	3mm Hex Key	3mm Hex Key
Environmental Characteristics							
Temperature — Operating (no derating)	-35° – 50°C	-35° – 50°C	-35° – 50°C	-35° – 50°C	-35° – 50°C	-35° – 50°C	-35° – 50°C
Temperature — Derate >50°C (max. 65°C)	-1% per °C	-1% per °C	-1% per °C	-1% per °C	-1% per °C	-1% per °C	-1% per °C
Temperature — Storage	-40° – 80°C	-40° – 80°C	-40° – 80°C	-40° – 80°C	-40° – 80°C	-40° – 80°C	-40° – 80°C
Altitude (Meters) — No Derating	2000	2000	2000	2000	2000	2000	2000
Altitude > 2000M	1% per 100 m	1% per 100 m	1% per 100 m	1% per 100 m	1% per 100 m	1% per 100 m	1% per 100 m
Humidity	95% Non-condensing						
Operating Position	Vertical ± 30°						
Impulse Withstand Voltage IEC 947-4-1	4000 V	4000 V	4000 V	4000 V	4000 V	4000 V	4000 V
Rated Insulation Voltage (Ui)	660V						
Installation Category	III						
Vibration	IEC 68-2-6 3g 10 – 150 Hz						
Shock	15g	15g	15g	15g	15g	15g	15g
Degree of Protection	IP20	IP20	IP20	IP20	IP20	IP20	IP20
Agency Approvals	UL, CSA, CE						

S801 Open Soft Starter

Solid-State Reduced Voltage Starters

Eaton's Cutler-Hammer Intelligent Technologies (***IT.***) line of Reduced Voltage Soft Starters is very compact, multifunctional, easy-to-install and easy-to-program. Designed to control acceleration and deceleration of 3-phase motors, the line is available in current ranges from 12 – 1000 amperes and is suitable for mounting in Motor Control Centers or in enclosed control (NEMA 1, 4, 4X and 12) applications.

This product line is designed to compete head-to-head with the high-end soft starter market, offering improved performance and dramatically smaller size versus the competition. By having the overload functionality and bypass contactors built into the unit, it reduces the amount of wiring required during installation and offers huge space savings in the panel or enclosure. The product is also designed to be small enough to replace an existing across-the-line starter (NEMA or IEC) in the existing enclosure. This allows customers to upgrade their existing motor control centers and enclosed control by replacing the starter they have today with a soft starter, gaining the benefits of lower utility charges, longer component life and less stress on products and material systems. This size benefit allows users to save the expense of replacing the existing structure or adding a new one to house a much larger soft starter.

Description

The S801 line uses a total of six SCRs to control the motor (three matched pairs). The unit has a built-in overload that is adjustable from 30% – 100% of rating and can be set for Trip Class 5, 10, 20 or 30. It also provides additional protection for jam, stall, phase reversal, phase loss, overtemperature, undervoltage, etc. Along with the overload, the unit has a built-in run bypass contactor. This device is closed when the soft starter is up to speed providing a low impedance bypass for the SCRs and significantly reducing the amount of heat that is generated in the soft starter.

The S801 is designed to work with 3-phase motors in a Delta (3-lead) configuration. The S801 works with all motors from fractional horsepower up to motors requiring 1000 amperes of steady state current. The built-in overload (in ranges from 12 – 1000 amperes) and run bypass contactor makes installation and setup quick and easy. The overload also offers some advanced protective functions to give additional motor protection.

With the pump control option, it is the number one soft starter available for pumping applications. The unique soft stopping control provides a smooth transition for stopping a motor and eliminating the "water-hammer" effect that can damage pipes, valves and pumps.

Standards and Certifications

- IEC 947 compliant.
- EN 60947-4-2.
- CE marked.
- CSA certified.
- UL listed.

Table 31.6-15. Catalog Numbering System

S 801 N 66 N 3 S

S = *IT.* Soft Starter **S** = Non-combination Soft Starter		**Frame Size Inches (mm)** **N** = 2.56 (65) **R** = 4.33 (110) **T** = 7.87 (200) **V** = 11.42 (290)	**Ampere Rating** **N37** = 37 Amperes **N66** = 66 Amperes **R10** = 105 Amperes **R13** = 135 Amperes **T18** = 180 Amperes **T24** = 240 Amperes **T30** = 304 Amperes **V36** = 360 Amperes **V42** = 420 Amperes **V50** = 500 Amperes **V65** = 650 Amperes **V72** = 720 Amperes **V85** = 850 Amperes	**Options** **N** = No Enclosure	**Number of Poles** **3** = 3-Pole Device	**Control Options** **S** = Soft Starter Overload **L** = Extended Ramp Start

Features

- Built-in overload protection:
  - 30% –100% adjustment range
  - Trip Class 5, 10, 20 and 30
  - Jam
  - Stall
  - Phase reversal
  - Phase loss/unbalance
  - Shorted SCR detection
  - Overtemperature
- Selectable ramp or current limit start.
- Kick Start:
  - Adjustable from 0% – 85% initial torque
  - .0 – 2.0 seconds adjustment time
- Ramp Start:
  - Adjustable from 0% – 85% initial torque
  - .5 – 180 seconds adjustment time
- Current Limit Start:
  - Adjustable from 0% – 550% FLA
  - .5 – 180 seconds adjustment time
- Soft Stop:
  - Adjustable from 0% – 60 seconds
- Built-in run bypass contact.
- 24 Vdc control.
- IP20 finger protection.
- Optional pump control.

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Enclosed Soft Starter

Enclosed Soft Starter

Product Description

24 Vdc Control — ***IT.*** Soft Starters superiority begins with the control package which features 24 Vdc control running a Digital Signal Processor, or DSP, and utilizing a low impedance run circuit, all of which contribute to the ***IT.*** Soft Starter's safety, advanced functionality and compact size.

Built-in Overload Protection — With most Y-Delta starters, many of the advanced features of ***IT.*** are functions that must be added at the expense of cost and space. The ***IT.*** Soft Starter, for example, has built-in overload protection (overloads must be added to Y-Delta starters). So ***IT.*** Soft Starters are more compact, easier to wire and less costly than their Y-Delta counterparts.

Reduced Power Consumption — The ***IT.*** Soft Starter costs less in terms of power consumption. An ***IT.*** Soft Starter also reduces line brown-outs and decreases overall energy usage. For example, an ***IT.*** Soft Starter controls peak power demand while a full-voltage starter can apply 600 – 800% FLA on start-up.

Lower Starting Torque — System cost savings are significant with an ***IT.*** Soft Starter versus a full voltage starter. With an ***IT.*** Soft Starter, mechanical components can have longer life or be reduced in size because of lower starting torque values (250 – 500% FLA current with SSRV).

Fewer Mechanical Problems — Because an ***IT.*** Soft Starter reduces stress on a system by eliminating the jolts and violent speed variations that full-voltage starters introduce to a process, fewer mechanical breakdowns occur, improving the quality of the product and process.

Features and Benefits

- **Longer Life of System Equipment** — With the impressive list of control and protective functions, this new line of products is designed to significantly increase the protection it offers to system equipment (e.g., motors, belts, pumps, etc.). The benefit of increased system equipment protection is longer life and longer system equipment uptime.
- **Reduced Power Draw** — Power control features like Ramp Start, Current Limit Start and Jog Forward provide maximum flexibility in selecting start profiles, minimizing both mechanical and electrical stress while maximizing motor performance.
- **Improved Safety** — ***IT.*** Soft Starters offer fingerproof deadfront construction, reducing the chance of electrical shock. With the use of 24 Vdc control power, pilot devices and relays can be operated more safely.
- **System Cost Savings** — With improved reliability, longer life of system equipment, reduced power draw, space savings and improved safety, you enjoy the benefit of a significant improvement in system uptime and a reduction in system downtime resulting in overall system cost saving.
- **Time Savings** — Time savings in using Intelligent Technologies Soft Starters are achieved through a quick and easy setup procedure, user-friendly operational design, the longer life of system equipment and improved safety.
- **Productivity** — Overall, Intelligent Technologies Soft Starters significantly improve your productivity by saving you time and money. This is demonstrated by longer product life, longer runs between breakdowns and the ease of installation and operation.

Standards and Certifications

- UL 508.
- IEC 947-4-2.
- EN 60947.2.
- CE marked EMC/LV directives.
- CSA – 22.2.

Schematic Diagram

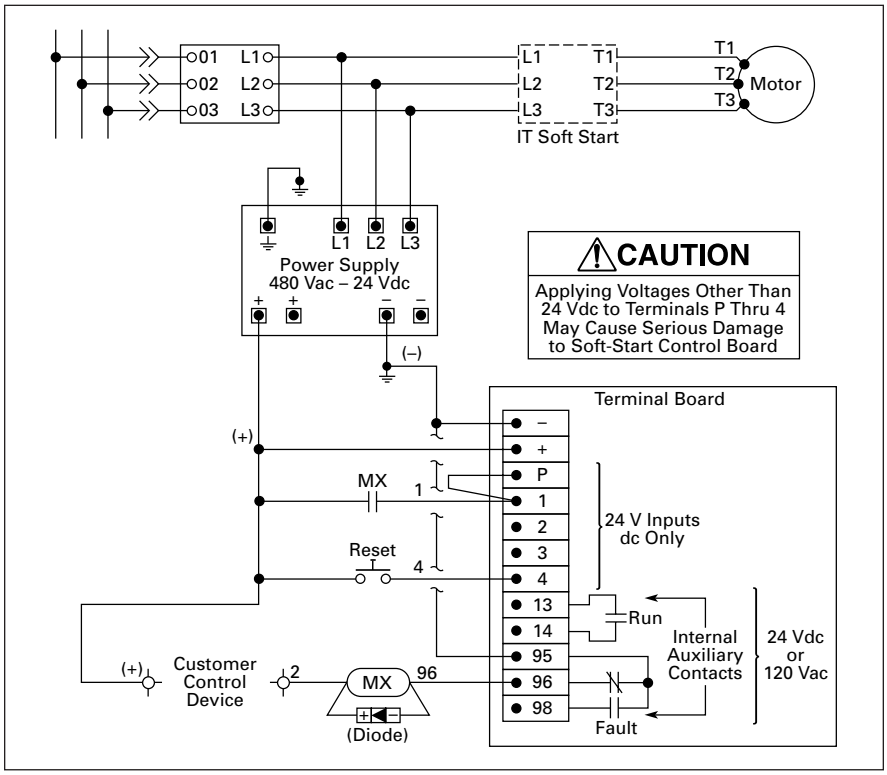


Figure 31.6-3. Wiring Diagram

Base Ratings

Table 31.6-17 below is the base ratings for the Intelligent Technology Soft Starter. The tables included in this catalog are meant to be a selection table for different applications, but to match a unit to your exact application, consult with your local Eaton representative or visit our Web site at **www.EatonElectrical.com**.

Table 31.6-16. Standard Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft Start	300%	30	3	50°C
vs. Full Voltage	500%	10	3	50°C
vs. Wye-Delta	350%	20	3	50°C
vs. 80% RVAT	480%	20	2	50°C
vs. 65% RVAT	390%	20	3	50°C
vs. 50% RVAT	300%	20.	4	50°C

Table 31.6-17. Standard Duty Rating Open Soft Starters

Frame Size	Maximum Current	3-Phase Motor											Catalog Number
		kW Rating (50 Hz)			hp Rating (60 Hz)								
		230	380 – 400	440	200 V		230 V		460 V		575 V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	37 66	10 18.5	18.5 30	18.5 37	10 20	10 15	10 20	10 20	25 50	20 40	30 60	30 50	**S801N37N3S** **S801N66N3S**
R	105 135	30 40	55 63	59 80	30 40	25 30	40 50	30 40	75 100	60 75	100 125	75 100	**S801R10N3S** **S801R13N3S**
T	180 240 304	51 75 90	90 110 160	110 147 185	60 75 100	50 60 75	60 75 100	60 75 100	150 200 250	125 150 200	150 200 300	150 200 250	**S801T18N3S** **S801T24N3S** **S801T30N3S**
V	360 420 500 650 720 850 1000	110 129 150 200 220 257 315	185 220 257 355 400 475 560	220 257 300 425 450 500 600	125 150 150 250 — — —	100 125 150 200 — — —	150 175 200 250 300 350 400	125 150 150 200 250 300 350	300 350 400 500 600 700 800	250 300 350 450 500 600 700	350 450 500 600 700 900 1000	300 350 450 500 600 700 800	**S801V36N3S** **S801V42N3S** **S801V50N3S** **S801V65N3S** **S801V72N3S** **S801V85N3S** **S801V10N3S**

Severe Duty Ratings

Motor applications and customer needs come in many different varieties. With the standard and severe duty rating tables, we have attempted to provide guidelines on what the Intelligent Technologies Soft Starter is capable of. If the application falls under these categories, you can use these charts. For other applications, or when a question arises, a program in Bid Manager is designed to assist you in selecting the proper soft starter.

Table 31.6-18. Severe Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft Start	450%	30	4	50°C
vs. Full Voltage	500%	10	10	50°C
vs. Wye-Delta	350%	65	3	50°C
vs. 80% RVAT	480%	25	4	50°C
vs. 65% RVAT	390%	40	4	50°C
vs. 50% RVAT	300%	60	4	50°C

Table 31.6-19. Severe Duty Rating Open Soft Starters

Frame Size	Maximum Current	3-Phase Motor											Catalog Number
		kW Rating (50 Hz)			hp Rating (60 Hz)								
		230	380 – 400	440	200 V		230 V		460 V		575 V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	22 42	5.5 11	10 18.5	11 22	5 10	5 10	7-1/2 15	5 10	15 30	10 25	20 40	15 30	**S801N37N3S** **S801N66N3S**
R	65 80	15 22	30 40	33 45	15 25	15 20	20 30	15 25	50 60	40 50	50 75	50 60	**S801R10N3S** **S801R13N3S**
T	115 150 192	33 45 55	59 80 100	63 90 110	30 50 60	30 40 50	40 50 75	30 50 60	75 100 150	75 100 125	100 150 200	100 125 150	**S801T18N3S** **S801T24N3S** **S801T30N3S**
V	240 305 365 420 480 525 600	75 90 110 129 147 160 185	110 160 185 220 257 280 315	147 185 220 257 295 335 375	75 100 125 150 150 150 200	60 75 100 125 150 150 150	75 100 150 150 200 200 250	75 100 125 150 150 150 200	200 250 300 350 400 450 500	150 200 250 300 350 350 450	200 300 350 450 500 500 600	200 250 300 350 450 450 500	**S801V36N3S** **S801V42N3S** **S801V50N3S** **S801V65N3S** **S801V72N3S** **S801V85N3S** **S801V10N3S**

31

S801 — Starter

Advantages

- Able to fit in place of existing starters.
- Smallest unit on the market today.
- Very easy to install, wire and program.
- Reduces initial torque on motor and loads.
- Able to control the maximum inrush current.

Benefits

- Reduced wear on belts, gears, chains, clutches, shafts and bearings.
- Allows for controlling the inrush current to the motor and reducing electrical charges due to peak energy demand.
- Reduced inrush current leads to more stable power grid and can lower peak demand charges.
- Elimination of water-hammer which can reduce installed cost of pipe hangers and extend existing system life.
- Less shock to product on conveyor lines and material handling gear.
- 24 Vdc control enhances personnel and equipment safety.

Table 31.6-20. Technical Data

Soft Starter (Partial Catalog Number)	S801 N37	S801 N66	S801 R10	S801 R13	S801 T18	S801 T24	S801 T30	S801 V36	S801 V42	S801 V50	S801 V65	S801 V72	S801 V85	S801 V10
Maximum Current Capacity	37	66	105	135	180	240	304	360	420	500	650	720	850	1000
Dimensions in Inches (mm)														
Width	2.60 (66.1)		4.38 (111.3)		7.65 (194.3)			11.04 (280.4)						
Height	7.38 (187.4)		7.92 (201.2)		12.71 (322.8)			16.57 (420.9)						
Depth	6.63 (168.4)		7.03 (178.6)		6.69 (169.9)			7.69 (195.3)						
Weight in lbs. (kg)	5.80 (2.6)		10.50 (4.8)		48.00 (21.8) — with Lugs 41.00 (18.6) — without Lugs			103.00 (46.0) — with Lugs 91.00 (41.4) — without Lugs						
General Information														
Bypass Mechanical Lifespan	10M													
Insulating Voltage (Ui)	660 V													
Ramp Time Range	.5 – 180 Seconds (.5 – 360 Seconds Extended Ramp)													
Resistance to Vibration	3g													
Resistance to Shock	15g													
Electrical Information														
Operating Voltage	200 – 600 V													
Operating Frequency	47 – 63 Hz													
Overload Setting	30% – 100%													
Trip Class	5, 10, 20 and 30													
Cabling Capacity (IEC 947)														
Number of Conductors	1		1		1 or 2			2, 4 or 6						
Wire Sizes	14 – 2		14 – 4/0		2/0 to 500 kcmil			2/0 to 500 kcmil						
Type of Connectors	Box Lug		Box Lug		Add-on Lug Kit			Add-on Lug Kit						
Control Wiring (12-Pin)														
Wire Sizes in AWG	22 – 14													
Number of Conductors (Stranded)	2 (or one AWG 12)													
Torque Requirements in lb-in.	3.5													
Solid, Stranded or Flexible Maximum Size in mm^2	3.31													
Control Power Requirements														
Voltage Range (24 V ± 10%)	21.6 – 26.4							21.6 – 26.4						
Steady State Current Amperes	1.0							1.4						
Inrush Current Amperes	10							10						
Ripple	1%							1%						
Relays (1) Class A and C														
Voltage ac — Maximum	240													
Voltage dc — Maximum	120													
Amperes — Maximum	3													
Environment														
Temperature — Operating	-30°C – 50°C (No Derating) Consult Factory for Operation >50°C													
Temperature — Storage	-50°C – 70°C													
Altitude	<2000 Meters — Consult Factory for Operation >2000 meters													
Humidity	<95% Non-condensing													
Operating Position	Any													
Pollution Degree (IEC 947-1)	3													
Impulse Withstand Voltage (IEC 947-4-1)	4000 V													

S811 Open Soft Starters

Product Description

Eaton's Cutler-Hammer ***IT.*** S801 revolutionized the reduced voltage control marketplace with its advanced feature set and small size. In fact, readers of an industry leading control publication rated Cutler-Hammer Soft Starters best in customer satisfaction in March 2004. The new ***IT.*** S811 from Eaton's electrical business offers all the popular features of the S801, but adds enhanced functionality with the new DIM (Digital Interface Module) and communications capabilities.

The Cutler-Hammer Intelligent Technologies (***IT.***) Line of S811 Reduced Voltage Soft Starters is very compact, multi-functional, easy to install and easy to program. Designed to control the acceleration and deceleration of three-phase motors up to 690V, the line is available from 11 amps through 1,000 amps.

The S811 is designed to be a complete package combining the SCRs, bypass contactor and overload in one, very compact unit. The S811 is available as a component for panel mounting, in motor control centers or in enclosed control (NEMA Type 1, 3R, 4, 4X, 7/9 and 12).

Application Description

Designed to control the acceleration and deceleration of three-phase motors, the ***IT.*** S811 soft starter uses Silicon Controlled Rectifiers (SCRs) to control the voltage to soft start and soft stop the motor. After the motor is started, internal run bypass contactors close, resulting in the motor running directly across-the-line. The built-in solid-state overload protects the motor from overload conditions with sophisticated algorithms that model true motor heating, resulting in better motor protection and fewer nuisance trips. Advanced protective and diagnostic features reduce downtime.

A voltage ramp start or current limit start is available. Kick start is available in either starting mode. The soft stop option allows for a ramp stop time that is longer than the coast to stop time. The pump control option provides a smooth transition for starting and stopping a motor and eliminating the "water-hammer" effect that can damage pipes, valves and pumps.

The S811 offers an impressive array of advanced protective features. Not only are the protective features selectable, but many offer variable settings allowing the user to fine tune the starter to meet specific system requirements.

The S811 has an easy to use Digital Interface Module (DIM) that allows the user to configure the device and to read system parameters. The DIM includes an LCD display and keypad to scroll through the various menus. The DIM allows the user to modify control parameters, enable or disable protections, set communication variables, monitor system parameters such as line voltages and currents, and access the fault queue.

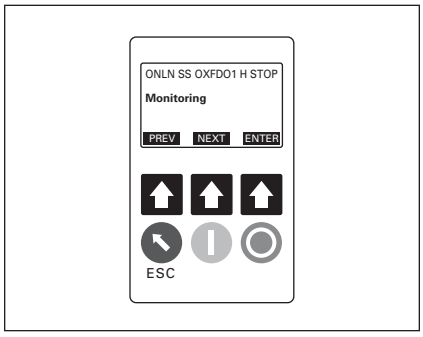


Figure 31.6-4. Digital Interface Module (DIM)

The DIM can be removed from the S811 and remote mounted. Kits are available to door mount the DIM, enabling users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door.

The S811 has built-in communications capabilities through Cutler-Hammer QC (Quick Connect) Port. The QCPort enables the soft starter to be connected to a variety of networks, including DeviceNet™ and EtherNet/Modbus®. The advantage of QCPort is that multiple control components can be connected to one Cutler-Hammer gateway. The gateway concentrates data from the devices into a single node. Configuration is simple — a single press the gateway's Auto Configuration button sets the system up for default operation. This automatically configures the I/O assemblies to the QCPort system devices. The data from these devices are then assembled into a single input and output messages.

The S811 communication parameters can be configured with the DIM or through the network using CH Studio Component Manager. Advanced communication configuration settings provide the system integrator with powerful tools to facilitate system optimization.

Features and Benefits

- The DIM (Digital Interface Module) provides an intuitive, easy-to-use human interface with powerful configuration capabilities to maximize system performance.
- Door or device mounted DIM enables users to safely configure, commission, monitor and troubleshoot the system at the electrical panel without opening the enclosure door.
- System operating parameters can be monitored enterprise-wide through a communications network. Increase uptime by providing data for process management and preventive diagnostics.
- Run bypass mode greatly reduces internal heating created by the greater power dissipation in the SCRs. Bypass contactor directly connects the motor to the line and improves system efficiency by reducing internal power losses.
- Internal solid-state overload protection provides accurate current measurement and trip settings. Sophisticated algorithms solve a series of differential equations that model true motor heating and cooling, resulting in superior motor overload protection while minimizing nuisance trips. Advanced selectable protective features safeguard the motor and system against a variety of system faults.

- Internal run bypass contactors and overload protection eliminate the need for additional devices, reducing enclosure sizes, minimizing installation and wiring time and reducing overall assembly size and cost.
- Wide range of overload FLA settings (31 – 100% of rated current) and a selectable trip class (5 – 30) offers users the flexibility to fine tune the starter to match specific application requirements.
- Variable ramp times and torque control settings provide unlimited starting configurations, allowing for maximum application flexibility.
- Kick-start feature enables soft starting of high friction loads.
- Soft stop control for applications where an abrupt stop of the load is not acceptable.
- Pump control option with sophisticated pump algorithms on both starting and stopping that minimize the pressure surges that cause water hammer. The pump control option will maximize the life of the pump and piping systems while minimizing the downtime caused by system failure.
- Six SCRs control all three motor phases, providing smooth acceleration and deceleration performance.
- Soft acceleration and deceleration reduces wear on belts, gears, chains, clutches, shafts and bearings.
- Reduce the peak inrush current's stress on the power system.
- Minimize peak starting torque to diminish mechanical system wear and damage.
- 24 Vdc control module enhances personnel and equipment safety.
- Removable, lockable control terminal block reduces maintenance costs. Also provides the opportunity for OEMs to reduce assembly and test costs by utilizing pre-assembled wire harnesses.

Protective Features

All protective features can be configured, enabled or disabled with the DIM or through the communications network.

Motor Overload

The S811 includes electronic overload protection as standard. The overload meets applicable requirements for a motor overload protective device. The overload protects the motor from over heat conditions with the use of sophisticated algorithms that model true motor heating, resulting in superior motor protection and fewer nuisance trips.

The S811 calculates a thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur removing power to the motor. Upon trip, the S811 stores the calculated motor heating value and will not allow a motor re-start until the motor has sufficiently cooled. This feature ensures the motor will not be damaged by repeated overload trip, reset and re-start cycles.

The thermal memory value can be monitored through the DIM or the communications network. The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs halting the process. Costly system downtime can be avoided.

The trip current is adjusted to match the specific application requirements by entering the motor nameplate full load current rating and trip class. The FLA adjustment includes a 3 to 1 adjustment range. The overload trip class is adjustable from class 5 through class 30. The overload is ambient temperature compensated — meaning its trip characteristics will not vary with changes in ambient temperature. The overload protection can be enabled, disabled, or disabled on start.

Short Circuit

The use of a short circuit protective device in coordination with the S811 is required in branch motor circuits by most electrical codes. Short circuit coordination ratings with both fuses and Cutler-Hammer molded case circuit breakers are available providing customers with design flexibility. The S811 has short circuit coordination ratings as an open component, an enclosed starter, and in a motor control center.

Jam

Excessive current and torque up to locked rotor levels can occur in a jam condition. The condition can result in stress and damage to the motor, load, mechanical system, and the electrical distribution system. Jam protection prevents the stress and damage from a jam during normal run. After the motor is started, a current greater than 300% FLA setting will cause the starter to trip on a jam fault.

Stall

Excessive current and torque up to locked rotor levels can occur in a stall condition. The condition can lead to an overload trip and result in stress and damage to the motor, load, mechanical system, and the electrical distribution system. Stall protection prevents stress and damage to a motor that has not come up to speed, or stalled after the soft start time. The S811 will trip to protect the system in the event that the motor did not get to the rated speed in the defined soft start period. A current greater than 200% FLA at the end of the soft start period will cause the starter to trip on a stall fault.

Pole Over Temperature

High ambient temperatures, extended ramp times and high duty cycle conditions may cause the S811 power pole conductors to reach a temperature that exceeds their thermal rating. The S811 is equipped with sensors that monitor the temperature of the power poles. Over temperature protection occurs if the device's thermal capacity is exceeded. The soft starter will trip in over temperature conditions, preventing device failure.

The device pole temperature value can be monitored through the DIM or the communications network. This feature can be of use in determining an impending over temperature trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system shutdown can be avoided.

Phase Loss

Loss of a phase can cause a significant increase in the current drawn in the remaining two phases. Phase loss can lead to motor damage before an eventual overload trip occurs. Phase loss is typically an indication of a failure in the electrical distribution system. The S811 will detect a phase loss and trip if any phase current drops below a preset value. The phase loss trip level is adjustable from 0% to 100% of the average of the other two phase levels with an adjustable trip delay of 0.1 to 60 seconds.

Phase Imbalance

Phase current or voltage imbalance can cause a significant increase in the current drawn in the remaining two phases. Phase imbalance can lead to motor damage before an eventual overload trip. Phase imbalance is typically an indication of a failure in the electrical distribution system or the motor. The S811 will detect both current and voltage phase imbalances and trip if any phase becomes imbalanced as compared to the average of the other two phases.

The phase current imbalance trip level is adjustable from 0% to 100% of the average of the current in the other two phases with an adjustable trip delay of 0.1 to 60 seconds.

The phase voltage imbalance trip level is adjustable from 0% to 100% of the average of the voltage in the other two phases with an adjustable trip delay of 0.1 to 60 seconds.

Reset Mode

The S811 can be set up for automatic or manual reset on trip. The manual reset mode requires the operator to physically press the RESET button located on the soft starter. The overload can be manually reset through the DIM or through the communications network. The overload can also be electrically reset by energizing a 24 Vdc input on the control terminal block.

The automatic reset mode allows the soft starter to be automatically reset as soon as the trip condition is no longer present. With the automatic reset mode, after the fault is no longer present, the motor will be restarted as soon as a valid start signal is present.

Phase Reversal

The S811 can determine if the proper line phase sequence is present by default. The device will trip if the line phase sequence is something other than A-B-C. The S811 can be configured to operate under reversed phase conditions (A-C-B).

Shorted SCR Detection

The S811 monitors the operation of the power poles and will trip under a shorted SCR condition.

Open SCR Detection

The S811 monitors the operation of the power poles and will trip under an open SCR condition.

Low Current

Low current conditions can be a result of a loss of load or a failure in the mechanical system. The S811 has low current protection that will trip if the average rms current falls below a preset value. The low current protection can be programmed as a percent of motor FLA from 0% to 100%.

Low Voltage

Low voltage conditions can result from disturbances in the electrical power distribution system. Low voltage conditions can cause a malfunction and damage to electrical equipment. The S811 has low voltage protection that will trip if the average rms voltage falls below a preset value. The low voltage protection can be programmed as a percent of nominal voltage from 1% to 99% with a trip delay of 0.1 to 60 seconds.

High Voltage

High voltage conditions can result from disturbances in the electrical power distribution system. High voltage conditions can cause malfunctions or failures of electrical equipment. The S811 has high voltage protection that will trip if the average rms voltage is greater than a preset value. The high voltage protection can be programmed as a percent of nominal voltage from 101% to 120% with a trip delay of 0.1 to 60 seconds.

Monitoring Capabilities

The S811 has an impressive array of system monitoring capabilities that allow users to access real time process and diagnostic data. This data can be viewed at the device with the DIM or through a communications network. Data over a communications network can provide valuable insight into the condition of the equipment and processes. Maintenance and production personnel can monitor critical operational and maintenance data from a central control station that can be located far away from the production facility. Process data can be monitored to determine system anomalies that may indicate a need for preventive maintenance or an impeding failure. Adjustments made through the communications network can reduce costs by minimizing the time traveling to the location where the motor controls are located. When faults do occur, real time fault data can assist maintenance in troubleshooting and planning repair resources. Remote reset signals can be given to tripped devices without the need for manual intervention by maintenance personnel.

Average Line Current

Provides the average of the three-phase rms line currents in amps, accurate to within 2%. Current data can be used to indicate a need for maintenance. Increased currents in a fixed load application can indicate a reduction in system efficiencies and performance, signifying system maintenance is due.

Average Pole Current

Provides the average of the three-phase rms pole currents in amps, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications, and will differ in inside-the-delta applications.

Average line current as a % FLA

Provides the average rms line current as a percentage of the S811 FLA setting.

Three-Phase Line Currents

Provides three rms phase line currents in amps, accurate to within 2%. Imbalances or changes in the relative phase current to one another can indicate anomalies in the motor or electrical distribution system.

Three-Phase Pole Currents

Provides three rms phase pole currents in amps, accurate to within 2%. The pole current is the current through the soft starter. The line and pole current will be identical in in-line applications, and will differ in inside-the-delta applications.

Three-Phase Line Voltages

Provides the individual rms three-phase line voltages. Imbalances or changes in the relative phase voltage to one another can indicate anomalies in the motor or electrical distribution system. Voltage can be used to monitor electrical distribution system performance. Warnings, alarms and system actions to low or high voltage conditions can be implemented.

Percent Thermal Memory

Provides the real time calculated thermal memory value. The S811 calculates thermal memory value. A 100% value represents the maximum safe temperature of the motor. When the thermal memory value reaches 100%, an overload trip will occur, removing power to the motor.

The thermal memory value can be of great use in determining an impending overload trip condition. Alarms can be implemented in the process monitoring system warning of an impending trip before a trip occurs, halting the process. Costly system downtime can be avoided.

DC Control Voltage

Monitors level of the 24 Vdc control voltage. Fluctuations in control voltage can cause component malfunction and failure. System control voltage data can be used to implement warnings, alarms and system actions to low or high voltage conditions.

Pole Temperature

Increases in pole temperature are caused by increases in ambient temperature, start/stop times and start duty cycles. Changes in pole temperatures represent a change in system operating conditions. Identifying unexpected operating conditions or changes can prompt maintenance and aid in process evaluation activities.

Device Temperature

An increase in device temperature is a strong indication of an increase in ambient temperature. High ambient temperature operation can be identified with the Device Temperature data. Ambient temperature increases can be due to loss of enclosure cooling fans or blocked venting. High ambient temperatures will reduce the life of all electrical equipment in the enclosure.

Start Count

Start count data can be used to monitor system output, schedule preventative maintenance, identify system anomalies and identify changes in system operation.

Diagnostics

Fault Queue

Current fault and a fault queue containing the last nine system faults can be read through the DIM or communications network. Fault identification can minimize troubleshooting time and cost. The fault queue can be remotely accessed through a communications network to assist in planning maintenance resources. 30 different faults can be identified by the S811.

Control Status

The S811 provides data that represents system conditions that can be read through the DIM or the communications network. This data identifies the status of the system and the control commands the system is requesting of the S811. This can be used for advanced troubleshooting and system integration activities.

Breaker Status

The S811 has provisions to read and display circuit breaker status. Cutler-Hammer communicating Cover Control or other communicating protective device is required to take advantage of this feature.

User Manual

A comprehensive user manual is available and can be downloaded free of charge from www.EatonElectrical.com by performing a document search for MN03902002E.

Accessories

Surge Suppressors

A surge suppressor can mount on either the line or load side of the ***IT.*** Soft Starter. It is designed to clip the line voltage (or load side induced voltage).

Surge Suppressor

Surge Suppressor Mounted on a 200 mm Device

Table 31.6-21. Surge Suppressors

Description	Catalog Number
600 V MOV for 65 mm and 110 mm units	**EMS38**
600 V MOV for 200 mm and 290 mm units	**EMS39**
690 V MOV for 200 mm and 290 mm units	**EMS41**

Catalog Number Selection

Table 31.6-22. S811 Open Soft Starters Catalog Numbering System

S 811 T 30 N 3 S

S = ***IT.*** Soft Starter

811 = Non-combination Soft Starter

Frame Size
N = 65 mm
R = 110 mm
T = 200 mm
V = 290 mm

Ampacity Rating

37 = 37 amps	**36** = 360 amps
66 = 66 amps	**42** = 420 amps
10 = 105 amps	**50** = 500 amps
13 = 135 amps	**65** = 650 amps
18 = 180 amps	**72** = 720 amps
24 = 240 amps	**85** = 850 amps
30 = 304 amps	**10** = 1000 amps

N = No Options
P = Pump Control
V = 690 V Option
(Frame T18 through V85)

3 = 3-Pole Device

S = Standard Soft Starter (edge sensing is default of selectable setting)
L = Extended Ramp Start
W = Without DIM

Operation

Starting and Stopping Modes

The S811 has a variety of starting and stopping methods to provide superior performance in the most demanding applications. The motor can be started in either Voltage Ramp Start or Current Limit Start mode. Kick Start and Soft Stop are available within both starting modes.

Voltage Ramp Start

Provides a voltage ramp to the motor resulting in a constant torque increase. The most commonly used form of soft start, this start mode allows you to set the initial torque value and the duration of the ramp to full voltage conditions. Bypass contactors close after ramp time.

- Adjustable initial torque 0 – 85% of locked rotor torque.
- Adjustable ramp time 0.5 – 180 seconds (can be extended with factory modification).

Current Limit Start

Limits the maximum current available to the motor during the start phase. This mode of soft starting is used when it becomes necessary to limit the maximum starting current due to long start times or to protect the motor. This start mode allows you to set the maximum starting current as a percentage of locked rotor current and the duration of the current limit. Bypass contactors close after current limit time.

- Maximum current of 0 – 85% locked rotor current.
- Adjustable ramp time 0.5 – 180 seconds (can be extended with factory modification).

Kick Start

Selectable feature in both Voltage Ramp Start and Current Limit Start modes. Provides a current and torque "kick" for 0 to 2.0 seconds. This provides greater initial current to develop additional torque to breakaway a high friction load.

- 0 – 85% of locked rotor torque
- 0 – 2.0 seconds duration

Soft Stop

Allows for a controlled stopping of a load. Used when a stop-time that is greater than the coast-to-stop time is desired. Often used with high friction loads where a sudden stop may cause system or load damage.

- Stop time = 0 – 60 seconds.

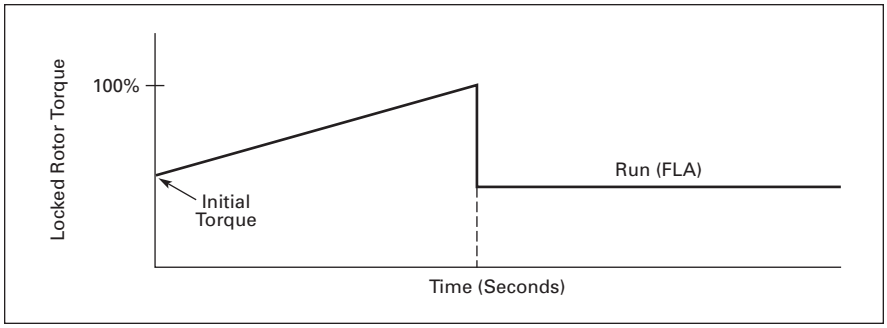


Figure 31.6-5. Starting Characteristics — Ramp Start

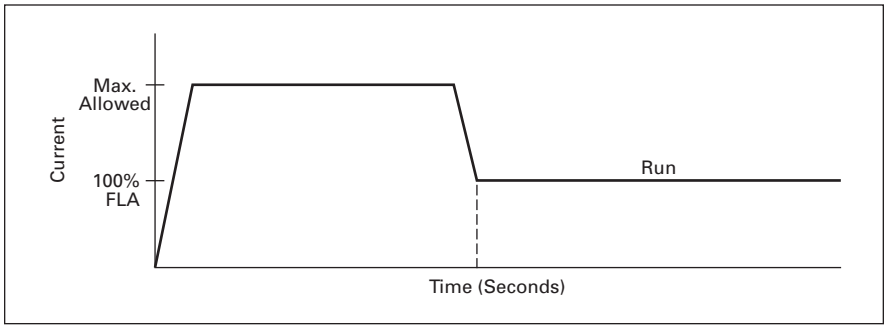


Figure 31.6-6. Starting Characteristics — Current Limit Start

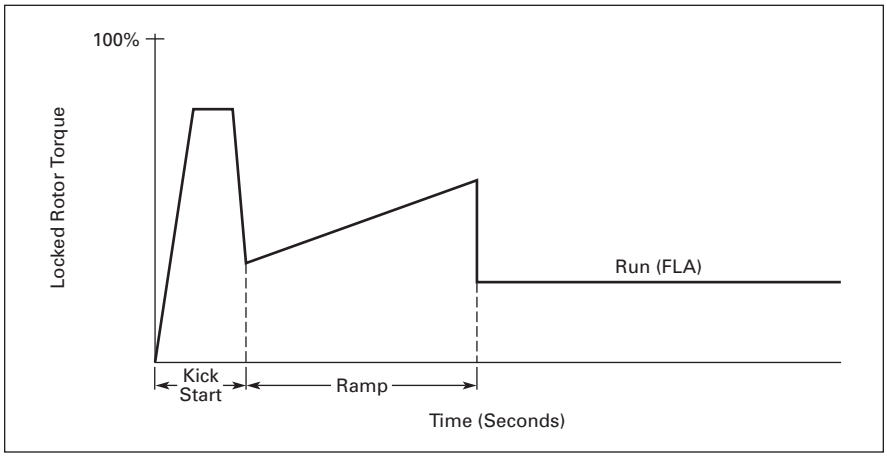


Figure 31.6-7. Starting Characteristics — Kick Start

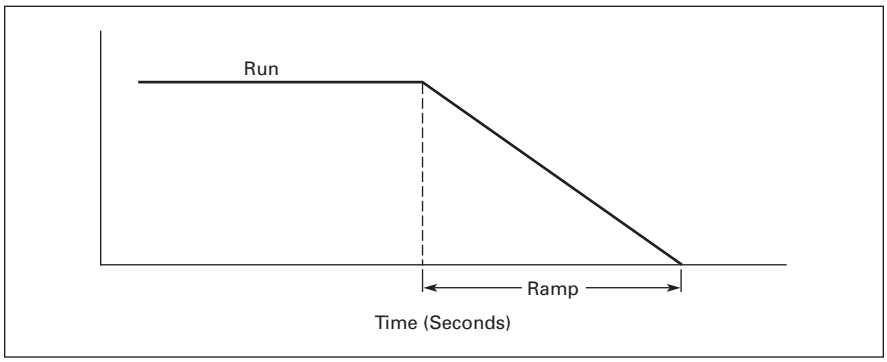


Figure 31.6-8. Starting Characteristics — Soft Stop

Product Selection

Motor applications and customer needs come in many different varieties. With the standard and severe duty rating tables, we have attempted to provide guidelines on what the ***IT.*** Soft Starter is capable of. If the application falls under these categories, you can use these charts. For other applications, or when a question arises, consult with your local Eaton Representative or call our Technical Resource Center.

Table 31.6-23. Standard Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft Start	300%	30 sec.	3	50°C
vs. Full Voltage	500%	10 sec.	3	50°C
vs. Wye-Delta	350%	20 sec.	3	50°C
vs. 80% RVAT	480%	20 sec.	2	50°C
vs. 65% RVAT	390%	20 sec.	3	50°C
vs. 50% RVAT	300%	20 sec.	4	50°C

Table 31.6-24. Product Selection — Standard Duty Rating Open Soft Starters

Frame Size	Max. Current	Three-Phase Motor											Catalog Number
		kW Rating (50 Hertz)			hp Rating (60 Hertz)								
		230	380 – 400	440	200 V		230 V		460 V		575 V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	37	10	18.5	18.5	10	10	10	10	25	20	30	30	S811N37N3S
	66	18.5	30	37	20	15	20	20	50	40	60	50	S811N66N3S
R	105	30	55	59	30	25	40	30	75	60	100	75	S811R10N3S
	135	40	63	80	40	30	50	40	100	75	125	100	S811R13N3S
T	180	51	90	110	60	50	60	60	150	125	150	150	S811T18N3S
	240	75	110	147	75	60	75	75	200	150	200	200	S811T24N3S
	304	90	160	185	100	75	100	100	250	200	300	250	S811T30N3S
V	360	110	185	220	125	100	150	125	300	250	350	300	S811V36N3S
	420	129	220	257	150	125	175	150	350	300	450	350	S811V42N3S
	500	150	257	300	150	150	200	150	400	350	500	450	S811V50N3S
	650	200	355	425	250	200	250	200	500	450	600	500	S811V65N3S
	720	220	400	450	—	—	300	250	600	500	700	600	S811V72N3S
	850	257	475	500	—	—	350	300	700	600	900	700	S811V85N3S
	1000	315	560	600	—	—	400	350	800	700	1000	800	S811V10N3S

Table 31.6-25. Severe Duty Ratings

Starting Method	Ramp Current % of FLA	Ramp Time Seconds	Starts per Hour	Ambient Temperature
vs. Soft Start	450%	30 sec.	4	50°C
vs. Full Voltage	500%	10 sec.	10	50°C
vs. Wye-Delta	350%	65 sec.	3	50°C
vs. 80% RVAT	480%	25 sec.	4	50°C
vs. 65% RVAT	390%	40 sec.	4	50°C
vs. 50% RVAT	300%	60 sec.	4	50°C

Table 31.6-26. Product Selection — Severe Duty Rating Open Soft Starters

Frame Size	Max. Current	Three-Phase Motor											Catalog Number
		kW Rating (50 Hertz)			hp Rating (60 Hertz)								
		230	380 – 400	440	200 V		230 V		460 V		575 V		
		Volt	Volt	Volt	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	1.0SF	1.15SF	
N	22	5.5	10	11	5	5	7-1/2	5	15	10	20	15	**S811N37N3S**
	42	11	18.5	22	10	10	15	10	30	25	40	30	**S811N66N3S**
R	65	15	30	33	15	15	20	15	50	40	50	50	**S811R10N3S**
	80	22	40	45	25	20	30	25	60	50	75	60	**S811R13N3S**
T	115	33	59	63	30	30	40	30	75	75	100	100	**S811T18N3S**
	150	45	80	90	50	40	50	50	100	100	150	125	**S811T24N3S**
	192	55	100	110	60	50	75	60	150	125	200	150	**S811T30N3S**
V	240	75	110	147	75	60	75	75	200	150	200	200	**S811V36N3S**
	305	90	160	185	100	75	100	100	250	200	300	250	**S811V42N3S**
	365	110	185	220	125	100	150	125	300	250	350	300	**S811V50N3S**
	420	129	220	257	150	125	150	150	350	300	450	350	**S811V65N3S**
	480	147	257	295	150	150	200	150	400	350	500	450	**S811V72N3S**
	525	160	280	335	150	150	200	150	450	350	500	450	**S811V85N3S**
	600	185	315	375	200	150	250	200	500	450	600	500	**S811V10N3S**

Technical Data

Table 31.6-27. Specifications — *IT.* Soft Starter

Soft Starter (Partial Catalog Number)	S811 N37	S811 N66	S811 R10	S811 R13	S811 T18	S811 T24	S811 T30	S811 V36	S811 V42	S811 V50	S811 V65	S811 V72	S811 V85	S811 V10 ①
Max. Current Capacity	37	66	105	135	180	240	304	360	420	500	650	720	850	1000
FLA Range	11 – 37	20 – 66	32 – 105	42 – 135	56 – 180	75 – 240	95 – 304	112 – 360	131 – 420	156 – 500	203 – 650	225 – 720	265 – 580	320 – 1000
Dimensions														
Width in Inches (mm)	2.66 (67.6)		4.42 (112.2)		7.67 (194.8)			11.05 (280.6)						
Height in Inches (mm)	7.38 (187.4)		7.92 (201.2)		12.71 (322.9)			16.57 (420.8)						
Depth in Inches (mm)	6.48 (164.5)		6.64 (168.7)		6.39 (162.4)			7.35 (186.6)						
Weight in lbs. (kg)	5.8 (2.6)		10.5 (4.8)		48 (21.8) with lugs 41 (18.6) without lugs			103 (46.8) with lugs 91 (41.4) without lugs						
General Information														
Bypass Mechanical Lifespan	10 M													
Insulating Voltage Ui	660 V													
Ramp Time Range	.5 – 180 Seconds (.5 – 360 Seconds Extended Ramp)													
Resistance to Vibration	3g													
Resistance to Shock	15g													
Electrical Information														
Operating Voltage	200 – 600 V													
Operating Frequency	47 – 63 Hz													
Overload Setting	30 – 100%													
Trip Class	5, 10, 20 & 30													
Cabling Capacity (IEC 947)														
Number of Conductors	1		1		1 or 2			2, 4 or 6						
Wire Sizes	14 – 2		14 – 4/0		4 AWG to 500 kcmil			2/0 to 500 kcmil						
Type of Connectors	Box Lug				Add-On Lug Kit									
Control Wiring (12-Pin)														
Wire Sizes in AWG	22 – 14													
Number of Conductors (Stranded)	2 (or one AWG 12)													
Torque Requirements in lb-in	3.5													
Solid, Stranded or Flexible Max. Size in mm^2	3.31													
Control Power Requirements														
Voltage Range (24 V ± 10%)	21.6 – 26.4													
Steady State Current Amps	1.0		1.0		1.0			1.4						
Inrush Current Amps	10		10		10			10						
Ripple	1%													
Relays (1) Class A and C														
Voltage ac — maximum	240													
Voltage dc — maximum	120													
Amps — maximum	3													
Environment														
Temperature — Operating	-30 – 50°C (No derating) Consult factory for operation > 50°C													
Temperature — Storage	-50 – 70°C													
Altitude	<2000 Meters — Consult factory for operation > 2000 m													
Humidity	<95% Non-condensing													
Operating Position	Any													
Pollution degree IEC947-1	3													
Impulse withstand Voltage IEC947-4-1	6000 V													

① UR Recognized Product

IT. Power Supply

Eaton's Cutler-Hammer ***IT.*** soft starters are powered using 24 Vdc control power. These switcher power supplies are DIN Rail mountable or can be panel mounted.

Typical IT. Power Supply

Table 31.6-28. DIN Rail Mounting Kit 1.38-inch (35 mm)

Description	Catalog Number
DIN Rail Mounting Kit 1.38-inch (35 mm)	**PSSDIN**

Note: For prices, consult sales office or price list.

Table 31.6-29. Specifications — *IT.* Power Supply

Catalog Number	PSS55A	PSS55B	PSS55C
Output Specifications			
Output Voltage Nominal Voltage Regulation	24 Vdc ±3%	24 Vdc ±3%	24 Vdc ±3%
Steady State Wattage	55W	55W	55W
Outrush Wattage Outrush Hold Up Time (mS)	240W 180 mS	240W 180 mS	240W 180 mS
Output Current	2.3 A	2.3 A	2.3 A
Maximum Capacitive Load	10,000 µF	10,000 µF	10,000 µF
Hold Up Time (mS)	120 mS	120 mS	120 mS
Overload Protection	Overcurrent shutdown with automatic restart	Overcurrent shutdown with automatic restart	Overcurrent shutdown with automatic restart
Input Specifications			
Input Voltage Nominal Voltage Range	115 Vac ±15%	230 Vac ±15%	360 – 480 Vac ±15%
Input Frequency	47 – 63 Hz	47 – 63 Hz	47 – 63 Hz
Input Current	.9A	.53A	.13A
Input Protection Inrush Current Overvoltage	 15 A 390 Vac	 30 A 390 Vac	 15 A 550 Vac
Fused	Yes	Yes	Yes
Switching Frequency	100 kHz	100 kHz	100 kHz
Efficiency (At Maximum Load)	80%	80%	85%
Maximum Ripple	±1%	±1%	±1%
Operating Specifications			
Dielectric Strength Input to Output	3 k Vac	3 k Vac	3 k Vac
Dielectric Strength Input/Output to DIN Rail	3 k Vac	3 k Vac	3 k Vac
Dielectric Strength Input to Ground	1.5 k Vac	1.5 k Vac	1.5 k Vac
Dielectric Strength Output to Ground	200 Vac	200 Vac	200 Vac
Temperature: Operating Storage	0°C – 50°C -40°C – 85°C	0°C – 50°C -40°C – 85°C	0°C – 50°C -40°C – 85°C
Altitude	<2000 meters, 20 to 85% RH	<2000 meters, 20 to 85% RH	<2000 meters, 20 to 85% RH
Operating Humidity	Non-condensing	Non-condensing	Non-condensing
Vibration	3g	3g	3g
RFI Specification	Class A	Class A	Class A
Degree of Protection (IEC529)	IP20	IP20	IP20
Insulation Stripping Length			
Wire Size Primary Clamp Screw Tightening Torque in lb-in (Nm)	20 – 12 AWG 4.38 (.5)	21 – 12 AWG 4.38 (.5)	22 – 12 AWG 4.38 (.5)
Wire Size Secondary Clamp Screw Tightening Torque in lb-in (Nm) Output Connections	20 – 12 AWG 4.38 (.5) 2	20 – 12 AWG 4.38 (.5) 2	20 – 12 AWG 4.38 (.5) 1
Insulation Stripping Length in Inches (mm)	.35-inch (8.9 mm)	.39-inch (9.9 mm)	.43-inch (10.9 mm)
Mounting Method DIN Rail Mounting Kit 1.4-inch (35.1 mm)	Panel Mount **PSSDIN**	Panel Mount **PSSDIN**	Panel Mount **PSSDIN**
Dimensions and Standards			
Mechanical Dimensions in Inches (mm)	2.09 x 3.90 x 5.60 (53 x 98 x 142)	2.09 x 3.90 x 5.60 (53 x 98 x 142)	2.30 x 4.20 x 6.80 (59 x 107 x 172)
Approximate Weight in lbs. (kg)	1.1 (.48)	1.1 (.48)	1.2 (.53)
Certifications/Standards	cULus, IEC	cULus, IEC	cULus, IEC

General Information — Technical Reference

Enclosure Types

Enclosures provide mechanical and electrical protection for operator and equipment. Brief descriptions of the various types of Cutler-Hammer enclosures offered by Eaton are given below. See NEMA Standards Publication No. 250 for more comprehensive descriptions, definitions and/or test criteria.

Type 1

Type 1 (Conforms to IP40) — for Indoor Use

Suitable for most applications where unusual service conditions do not exist and where a measure of protection from accidental contact with enclosed equipment is required. Designed to meet tests for rod entry and rust resistance. Enclosure is sheet steel, treated to resist corrosion. Depending on the size, knockouts are provided on the top, bottom and sometimes on the side.

Type 3R

Type 3R (Conforms to IP52) — for Outdoor Use

Primarily intended for applications where falling rain, sleet or external ice formations are present. Gasketed cover. Designed to meet tests for rain, rod entry, external icing and rust resistance. Enclosure is sheet steel, treated to resist corrosion. Depending on the size, a blank cover plate is attached to the top (for a conduit hub) and knockouts are provided on the bottom.

Cover-mounted pilot device holes are provided and covered with hole plugs.

Type 4 (Conforms to IP65) — for Indoor or Outdoor Use

Provide measure of protection from splashing water, hose-directed water and wind blown dust or rain. Constructed of sheet steel with gasketed cover.

Designed to meet tests for hose-down, external icing and corrosion protection. When conduit connections are specified, enclosure has two watertight hubs (power) installed top and bottom or one control hub installed in bottom — depending on size.

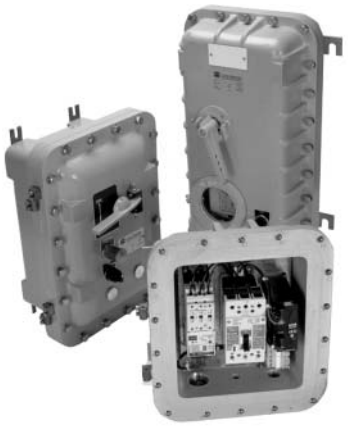
Cover-mounted pilot device holes are provided and covered with hole plugs.

Type 4X

Type 4X (Conforms to IP65) — for Indoor or Outdoor Use

Provide measure of protection from splashing water, hose-directed water, wind blown dust, rain and corrosion. Constructed of stainless steel with gasketed cover. Designed to meet same tests as Type 4 except enclosure must pass a 200-hour salt spray corrosion resistance test.

Provided as 304-grade stainless steel as standard. Select 316-grade option for improved corrosion resistance.



Type 7 & 9 Bolted

Type 7/9 — for Hazardous Gas Locations

For use in Class I, Group B, C or D; Class II, Groups E, F and Class III indoor locations as defined in the National Electrical Code. Type 7/9 enclosures must withstand the pressure generated by explosion of internally trapped gases and be able to contain the explosion so that gases in the surrounding atmosphere are not ignited. Under normal operation, the surface temperature of the enclosure must be below the point where it could ignite explosive gases present in the surrounding atmosphere. Designed to meet explosion, temperature and hydrostatic design tests.

Type 12

Type 12 — (Conforms to IP62) — for Indoor Use

Provide a degree of protection from dripping liquids (non-corrosive), falling dirt and dust. Designed to meet tests for drip, dust and rust resistance. Constructed of sheet steel. Hole plugs cover pilot device holes. There are no knockouts, hub cover plates or hubs installed.

Many Cutler-Hammer Type 12 enclosures are suitable for use in Class II, Division 2, Group G and Class III, Divisions 1 and 2 locations as defined in the National Electrical Code.

Type 12 — Safety Interlock

The Type 12 enclosure can be ordered with a safety interlock on the door that can be padlocked off. A vault-type door latch system is used. A tapered plate holds the gasketed door tight against the case edge to provide a positive seal. The special door interlock consists of the door handle and a screwdriver operated cover defeater.

The cover defeater and the disconnect interlock defeater are both recessed screwdriver operated devices which cannot be manipulated with other types of tools.

Table 31.7-1. IEC IP Index of Protection Ratings

1st Number	Description	2nd Number	Description
0	No Protection	0	No Protection
1	Protection Against Solid Objects Greater than 50 mm	1	Protection Against Vertically Falling Drops of Water
2	Protection Against Solid Objects Greater than 12 mm	2	Protection Against Dripping Water When Tilted Up to 15 Degrees
3	Protection Against Solid Objects Greater than 2.5 mm	3	Protection Against Spraying Water
4	Protection Against Solid Objects Greater than 1 mm	4	Protection Against Splashing Water
5	Total Protection Against Dust — Limited Ingress (Dust Protected)	5	Protection Against Water Jets
6	Total Protection Against Dust (Dust-Tight)	6	Protection Against Heavy Seas
—	—	7	Protection Against the Effects of Immersion
—	—	8	Protection Against Submersion

Table 31.7-2. NEMA Standard to IP Equivalence

Type	IP
1	40
3R	52
4	65
4X	65
12	62

Table 31.7-3. Enclosure Selection and Reference Chart — Box Dimensions

Box Designation	NEMA Enclosure Type	Width	Height	Depth
1	1	5.62 (142.7)	9.51 (241.6)	4.81 (122.2)
2	1	7.73 (196.3)	12.60 (320.0)	5.84 (148.3)
3	1	12.65 (321.3)	13.85 (351.8)	6.40 (162.6)
4	1	11.66 (296.2)	25.99 (660.1)	8.03 (204.0)
5	12, 3R, 4X	9.84 (250.0)	13.31 (338.1)	6.70 (170.2)
6	12, 3R, 4X	12.01 (305.1)	14.39 (365.5)	6.70 (170.2)
6A	12, 3R, 4X	12.01 (305.1)	14.39 (365.5)	8.44 (214.4)
7	12, 3R, 4X	12.26 (311.4)	14.37 (365.0)	6.70 (170.2)
7A	12, 3R, 4X	16.26 (413.0)	14.37 (365.0)	10.90 (276.9)
8	12, 3R, 4X	14.25 (362.0)	12.10 (307.3)	8.47 (215.1)
9	1, 12, 3R 4X	25.50 (647.7)	29.10 (739.1)	8.41 (213.6)
10	1, 12, 3R 4X	20.00 (508.0)	47.85 (1215.4)	10.48 (266.2)
A	1	10.50 (266.7)	27.06 (687.3)	6.66 (169.2)
A	12, 3R, 4X	10.50 (266.7)	28.98 (736.1)	6.66 (169.2)
A1	1	10.50 (266.7)	27.06 (687.3)	8.49 (215.6)
A1	12, 3R, 4X	10.50 (266.7)	28.98 (736.1)	8.49 (215.6)
B	1	15.50 (393.7)	23.06 (585.7)	6.66 (169.2)
B	12, 3R, 4X	15.50 (393.7)	24.98 (634.5)	6.66 (169.2)
B1	1	15.50 (393.7)	23.06 (585.7)	10.90 (276.9)
B1	12, 3R, 4X	15.50 (393.7)	24.98 (634.5)	10.90 (276.9)
C	1	20.50 (520.7)	30.50 (774.7)	8.44 (214.4)
C	12, 3R, 4X	20.50 (520.7)	32.36 (822.0)	8.44 (214.4)
D	1	29.50 (749.3)	35.00 (889.0)	8.75 (222.3)
D	12, 3R, 4X	29.50 (749.3)	38.10 (967.7)	8.75 (222.3)
E	1, 12, 3R, 4X	28.00 (711.2)	61.75 (1568.5)	10.68 (271.3)
F1E	1, 12, 3R, 4X	37.00 (940.0)	74.75 (1898.7)	19.25 (489.0)
F2E	1, 12, 3R, 4X	42.00 (1066.8)	92.90 (2360.0)	19.25 (489.0)
P1	1	8.50 (215.9)	32.98 (837.7)	6.66 (169.2)
P3	1	18.86 (479.0)	38.40 (975.4)	8.47 (215.1)
P5	1	21.00 (533.4)	48.40 (1229.4)	8.97 (227.8)
P7	1	28.80 (731.5)	60.58 (1538.7)	19.28 (489.7)
I	1, 12	8.62 (219.0)	27.06 (687.3)	6.66 (169.2)
J	1, 12, 3R	8.00 (203.2)	16.50 (419.1)	17.23 (437.6)
K	1, 12, 3R	8.00 (203.2)	19.50 (495.3)	7.23 (183.6)
L	1, 12, 3R	15.87 (403.1)	16.50 (419.1)	7.23 (183.6)
M	1, 12	15.87 (403.1)	24.50 (622.3)	7.23 (183.6)

Note: See Cutler-Hammer Enclosed Control guide or Web site for further details on enclosures.

Table 31.7-4. Non-combination Solid-State Reduced Voltage Box Dimensions

Ampere Rating	SSRV	Non-combination Box No. ①	Ampere Rating	SSRV	Non-combination Box No. ①
.8 – 27	S752	6A ②	304	S801/S811	G1
37	S801/S811	7A	360	S801/S811	G1
50	S752	6A ②	420	S801/S811	10
66	S801/S811	7A	500	S801/S811	10
105	S801/S811	7A	650	S801/S811	10
135	S801/S811	B1	720	S801/S811	10
180	S801/S811	C	850	S801/S811	10
240	S801/S811	G1	1000	S801/S811	10

① Enclosure space will also accommodate for an ***IT.*** Power Supply, two 4-pole relays, CPT, and terminal blocks. Also includes space for a DNA module or MOV.

② Same as footnote ①, but CPT is not included. Upsize to 7A enclosure to include space for a CPT and a full voltage bypass contactor.

Note: All Type 7 and 9, see **Section 11**.

Table 31.7-5. Combination Solid-State Reduced Voltage Box Dimensions

Ampere Rating	SSRV	Comb. with Fuses Box No. ③	Comb. with HMCP Box No. ③	Ampere Rating	SSRV	Comb. with Fuses Box No. ③	Comb. with HMCP Box No. ③
.8 – 27	S752	B1 ④	A1 ⑤	304	S801/S811	F1E	E
37	S801/S811	B1	A1 ⑤	360	S801/S811	F1E	E
50	S752	C	A1 ⑤	420	S801/S811	F1E	E
66	S801/S811	C	A1	500	S801/S811	F1E	E
105	S801/S811	D	B1	650	S801/S811	F1E	F1E
135	S801/S811	D	C	720	S801/S811	F1E	F1E
180	S801/S811	E	E	850	S801/S811	F1E	F1E
240	S801/S811	F1E	E	1000	S801/S811	F1E	F1E

③ Enclosure space will also accommodate for an ***IT.*** Power Supply, two 4-pole relays, CPT, and terminal blocks. Also includes space for a DNA module or MOV.

④ Enclosure may be reduced to an A1, with all space for all items as in footnote ③, excluding relays and CPTs.

⑤ Same as footnote ③, but CPT is not included. Upsize to B1 enclosure to include space for a CPT and a full voltage bypass contactor.

Note: For enclosure box dimensions, refer to table above.

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Application

Eaton's Cutler-Hammer Multi-Pak Group Control is designed to save time, space, and expense in installing motor control devices — whether for residential, commercial, or industrial buildings. The modular assembly allows versatile, on-the-job arrangement of Sizes 1 through 4 combination starters with ambient compensated relays, incoming or feeder circuit breakers or fusible disconnect switches, pushbuttons, control transformers, timers, relays, and fuses. The enclosures and separate, pre-wired modules are field-stocked and can be ordered individually, permitting field tailoring to suit the application.

Advantages

- Enclosures and pre-wired equipment modules are individually available from stock. Each shipping carton contains complete mounting and installation instructions.
- Cuts installation time by 25 percent. The pre-wired modules can be installed easily, using only a screwdriver, at the job site.
- Saves space over individually mounted control.
- Can be wall or rack mounted.
- Has flexible panel space for auxiliary control items. Barriers can be removed to provide oversized compartments.
- Eliminates square duct or cable entrance box.
- Simplifies wiring.
- Permits quick, easy additions and rearrangements.
- UL listed — E69852, Guide NITW.

Enclosure Features

The Type 1 enclosures are partitioned into either four or six compartments, to hold combination starter modules, incoming or feeder circuit breakers, fusible switches, or other auxiliary devices. The barriers can be removed to provide oversized spaces. Each enclosure holds up to four Size 1 or 2 full-voltage, nonreversing combination starter modules; up to two Size 3 or 4 starter modules, or a combination of both size ranges.

The compartments have hinged doors, interlocked to prevent opening when the breaker switch is in the ON position. The disconnect operating mechanism can be padlocked in the OFF position.

The enclosure and wireway cover plates come in ASA-70 light gray enamel. An identification card retainer is mounted on each compartment door.

A dust- and weather-resistant enclosure to house the Type 1 enclosure is also available.

Multi-Pak Four Compartment Enclosure Showing Variety of Possible Equipment Module Combinations Available

Typical Six Compartment Multi-Pak After Assembly

The Multi-Pak enclosure adapts easily to installation requirements. Multiple units can be arranged to suit the space available — horizontally on a single line or two-high. Knockouts are provided at the top, bottom and sides of the enclosures for conduit connection. Conduit can be installed and cables pulled as dictated by the construction schedule. Combination starter modules and incoming or feeder devices can be installed days, months or years later.

In addition to the barrier compartments, the enclosure contains two wiring troughs. The top section is a wireway fitted with three power terminal straps, each having terminals for extension to adjoining enclosures and to all four compartments. The incoming line and extension terminals are suitable for either copper or aluminum conductors, from No. 6 to 350 kcmil. At the bottom of the enclosure is another wiring trough for interconnecting wiring and outgoing cables.

Hinging of the front doors provides for easy access to each module. The doors are also gasketed with a fire-retardant material. Knockouts are provided on the doors for the mounting of pushbuttons and indicating lights.

Combination Starter Modules

Eaton's Cutler-Hammer Starter modules consist of a Class A200 magnetic linestarter, prewired with a motor circuit protector or a fusible DS disconnect switch on a panel. Full-voltage non-reversing and reversing, combination starters are available. An external reset button is mounted on the starter module door. With its versatile, modular design, the Multi-Pak starter permits a variety of motor control groupings. One module can contain many different arrangements of devices, such as combination linestarter with control transformers, and/or relays, or two feeder circuit breakers, or fusible switches.

The contactor design comprises a glass polyester case with silver-cadmium oxide alloy contacts, straight-through wiring, out-front terminals, molded coils, stainless steel kickout springs, U-type magnet, and a shock absorber baseplate.

The circuit breakers, equipped with adjustable magnetic trip elements, protect against short circuits. Standard 3-pole, inverse-time, and ambient compensated thermal overload relays protect against overload.

Fusible switches are equipped to accept either 250- or 600-volt Class H, K, and R cartridges fuses, with capacities as listed by Underwriters Laboratories for overcurrent protection.

ON-OFF operating mechanisms are molded from an ABS fire-resistant material.

Components of each module have individual printed labels identifying size, voltage, ampere rating, etc. The labels also contain a schematic drawing reference number covering the wiring of the component contained in the module.

Dimensions and Wiring Arrangements

Four compartment enclosures are 32.00 inches (812.8 mm) wide, 26.00 inches (660.4 mm) high, and 7.00 inches (177.8 mm) deep with provisions for four-bolt wall mounting. Six compartment enclosures are an additional 16.00 (406.4) inches wide. Enclosures may be grouped together by nippling through knockouts provided.

Load and control conduits may enter at the top or bottom. Starter wiring diagram and overload heater installation instructions are attached to each starter door.

Dust and weather-resistant enclosures for 4 or 6 module units are available. These enclosures are 34.00 inches (863.6 mm) or 50.00 inches (1270.0 mm) wide, 31.00 inches (787.4 mm) high, and 11.75 inches (298.5 mm) deep.

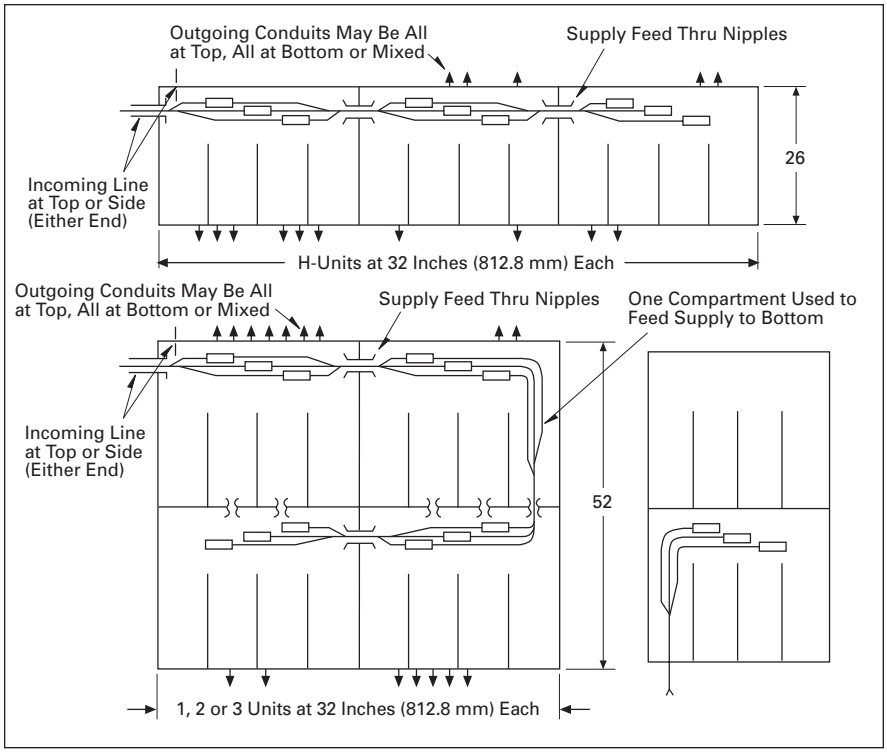
Outgoing Conduits May Be All at Top, All at Bottom or Mixed
Supply Feed Thru Nipples
26
Incoming Line at Top or Side (Either End)
H-Units at 32 Inches (812.8 mm) Each
Outgoing Conduits May Be All at Top, All at Bottom or Mixed
Supply Feed Thru Nipples
One Compartment Used to Feed Supply to Bottom
Incoming Line at Top or Side (Either End)
52
1, 2 or 3 Units at 32 Inches (812.8 mm) Each

Figure 31.8-1. Wiring Arrangements

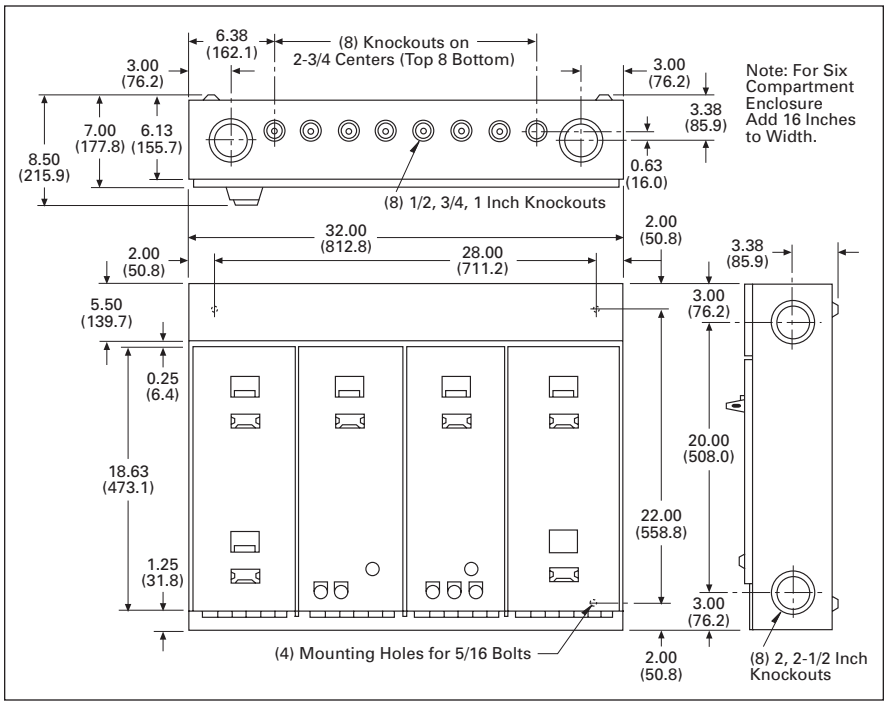

Figure 31.8-2. Type 1 Enclosures — Dimensions in Inches (mm)

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